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The Edison Convention. THE recent meeting at Minneapolis is an excellent example of the most useful sort of co-operation. To gather the exponents of a single system and freely discuss their various common interests requires just such special organization as now exists. There are many facts, however, brought out in the proceedings of the convention that possess a value not at all limited to the members. A paper like that of Mr. Jackson, for instance, contains much information that will prove very useful to electricians in general and very possibly stimulate the use of the little lamps that can be employed with beautiful effect in producing unique results in illumination. A magnificent example of such work due to the artistic skill of Mr. Stieringer was at hand to illustrate this special discussion. One of the features of the gathering was an elaborate report from the Electric Mutual Insurance Company, that should certainly be encouraging to central station managers. Until the present time the question of station insurance has not received a satisfactory answer, but it now appears as if we were to have brought about that harmony between electric and insurance interests that is so earnestly to be desired.

An Electric Headlight. PRACTICAL railroad men ought to take a lively interest in the electrical headlight described in our columns this week. The use of a powerful arc lamp raises the locomotive headlight from being a mere signal to the dignity of a search light, powerful enough to make evident obstructions at a sufficiently long distance to save a train from derailment. Previous experiments in this direction have been made, but the results have generally not been satisfactory, owing to complication in the apparatus and inefficient operation of the lamp. The present apparatus seems to have been reduced to its lowest terms in the matter of simplicity by the very ingenious device of using a lower electrode of copper for the arc, making the lamp nearly self-focusing, without involving the delicate mechanism usually found in lamps which preserve the arc at a constant point. It would appear to be a very useful safeguard in railway operation, for it is powerful enough to distinguish any probable obstruction several thousand feet in front of the engine, and that its merits are appreciated is sufficiently attested by the roads which have already adopted it.

Official Enthusiasm. THE last meeting of the Board of Electrical Control was particularly spicy. In the first place the lively row between the subway company and the unfortunate proprietors of underground wires was in full blast, and accusations of overcharges, fraudulent expense accounts and non-payment of rents were flying thick as the leaves of autumn. But the feature of the performance was the great original specialty act of the Mayor appearing in the rôle of electrical expert. Dr. Wheeler had brought in a formal report showing the death of lineman Kopp to have been due to his own carelessness. To the ordinary mind this would have settled the matter, but His Honor's is no plain everyday thinking apparatus, and the opportunity was too good to be lost. So there was a magnificent burst of official buncombe, and the report was scornfully refused. Can it be that the Mayor, mindful of the uncertainties that beset continuance of political grandeur, is looking with longing eyes at the position of expert to the Board, and is busily engaged in manufacturing an electrical reputation? The effort is entirely needless. He is already provided with one that is quite unique.

Iron for Electrical Purposes. SWINBURNE and Bourne's paper before the British Association bears striking evidence to the practical side of scientific measurements. It became necessary to test many samples of iron for their magnetic properties. The ordinary method by the ballistic galvanometer proved too tedious, so the authors arranged a species of induction bridge that enabled them to use a null method, and to work rapidly and accurately. The apparatus was exceedingly ingenious, and for testing a large number of similar samples would prove very useful. Nevertheless, it unluckily happens that in ordinary commercial practice the iron to be used is in all sorts of shapes and sizes, so that other instruments would have to be employed. It will not always do to examine iron by small samples, for their various properties may vary quite widely from what the same nominal grades of iron in large masses would exhibit. There is real need for a reasonably accurate practical method for measuring permeability; something applicable to samples, large enough fairly to represent the material and of shape convenient to prepare. In the lack of anything of that kind there is an unfortunate tendency to neglect magnetic constants and trust to rule of thumb and the uniformity of the iron furnished. Such a course may eventually produce excellent machines, but it is a rather costly kind of experimenting.

An Electric Railway Symposium. THE proceedings of the recent meeting of street railway men in Rochester make very interesting and suggestive reading. The gentlemen present seemed to have developed a very intelligent interest in electric traction, and subjected their brethren of the electrical companies to a rather rigid cross-examination as to the merits of their respective systems. The result was to bring out a great many facts that will prove of interest, both to electricians and street railway managers. The characteristic advantages of the overhead system now generally in use were most admirably shown, and the details of the construction, mechanical and electrical properties of the running gear and motors were explained with admirable clearness. The modifications introduced into the old Sprague system by the recent efforts of Mr. Edison will be new to most of our readers, and are full of interest. It is to be regretted that the new Westinghouse electric railroad system was not represented at the convention, for, aside from its successful operation, very little is generally known of it, and its presence could hardly have failed to add important facts to the lively "experience meeting" that was in progress. Gatherings of such a sort are most useful in bringing before an audience of investors the latest improvements in electric railways.

Anti-Effective Copper. A NEW incentive for economizing copper is very strikingly presented in the paper by Sir William Thomson, given elsewhere in our columns. Of course very many electricians are already familiar with the idea that a rapidly alternating current is only skin deep—rather a thick skin, to be sure, with the frequencies most generally used—but still only a layer. It seems very reasonable that the unused portion of the conductor might suffer from inductive effects, and the distinguished investigator has not only shown this to be the case, but has calculated the actual magnitudes of the losses under various conditions. It is somewhat surprising to find that these rise to an appreciable size even in the transformers in commercial use. The loss, to be sure, is small, but is doubly exasperating from the fact that one pays for the privilege of having it. It is possible to imagine cases, certain transformers used for electric welding for example, in which the losses from anti-effective copper would be quite perceptible. At present the general conditions under which alternating currents are used render the consideration of the conducting layer needless. If, however, there should be a tendency toward very high frequencies, there well might come a time when these theoretical considerations would acquire practical importance, and stranded, cored, or even hollow conductors would come into general use. At all events the question raised is a very instructive one.

To Electrical Students. THERE are to-day admirable opportunities for a young man who desires to enter the profession of electrical engineering. We illustrate this week only one of several admirable schools that give the requisite technical training and blend the theoretical and practical most successfully. But it takes something more than text-books and workshop experience to make a good electrician. The actual information acquired as to electrical theory and electrical systems is of small importance compared with the training that an alert mind can receive from this very instruction in passing from special cases to general principles, and in learning to profit intelligently from the results of others' experience. We are now in a transition period of electrical theory; the old ideas are giving way to new and simpler ones, and no student who fails to follow up the process of evolution is doing his duty by himself or his opportunities. These changes of which we speak are not at all Nihilistic—they involve a change of standpoint rather than of scene. They will not be found in the text-books as yet, and it is the object of this note to impress the necessity of following up this progress from week to week and month to month in the current electrical literature. Important papers will be found in journals and monographs published in this and other countries, some of them simple and some very abstruse, but all adding to electrical knowledge. Watch for them and read them, for they form a very necessary supplement to the thorough training of the technical school. The man who neglects the advances that are being made during his professional education is not likely to keep pace with them afterward.

Electrical Suicide. IT would be hard to find a more sickening exhibition of human stupidity than was apparent in some of the comments on the latest electrical accident. A laborer walks through a crowded railway yard utterly regardless of warnings and trusting to luck to escape injury; a train backs down on him, and the morning's paper, in a five line notice, mentions the fatal accident. An electric lineman goes out on a rainy night to repair a lamp, and, disregarding all precautions, leaves his rubber gloves at the station, climbs an iron pole, straps himself to it, and then manipulates wires known to be carrying a very dangerous current, with a pair of steel pliers. He is careless, knowing well the dangers of the work and how to avoid them, and pays the penalty with his life. Immediately there is another outcry against the dangers of electricity, and in half the daily papers "scare" headlines cover blood-curdling accounts of the work of the "deadly current." Even the Mayor is quoted as exhibiting his profound knowledge of electricity and of law by saying that "the company that is responsible should be indicted for murder, provided, of course, there is proof that it has been negligent." Of course an accident like that which caused the death of lineman Kopp is a sad and unfortunate thing, but why there should be a wild commotion over it, while almost daily men in other employments die from the results of far less reckless negligence, and are returned to earth unnoticed, we fail to see. To be sure, the accident occurred in a conspicuous place, but there is the same maudlin powwow over death by electricity whenever and wherever it happens. A high-tension current is known to be deadly, and the conditions which produce danger are well understood. It should be handled as carefully as a loaded pistol. Why, then, should there be wild excitement when a man falls a victim to the one and only a grim comment on "fools and firearms" when he dies by careless handling of the other?

Moonlight Tables for October.

Herewith we give Mr. H. W. Frund's table of lighting hours for the month of October, under his modified form of moon schedule.

Schedule for October, 1890.

TABLE NO. 1. Standard Moonlight Philadelphia System.				TABLE NO. 2. Frund's New Moonlight System.			
Date.	Light.	Date.	Extinguish	Date.	Light.	Date.	Exting.
1	6:15 P.M.	1	8:45 P.M.	1	6:15 P.M.	1	12:00 M.
2	6:15	2	9:25	2	6:15	2	12:00
3	6:15	3	10:05	3	6:15	3	12:00
4	6:15	4	10:50	4	6:15	4	12:00
5	6:00	5	11:40	5	6:00	5	12:00
6	6:00	7	12:35 A.M.	6	6:00	7	12:35 A.M.
7	6:00	8	1:30	7	6:00	8	1:30
8	6:00	9	2:30	8	6:00	9	2:30
9	6:00	10	3:35	9	6:00	10	3:35
10	6:00	11	5:10	10	6:00	11	5:10
11	6:00	12	5:10	11	6:00	12	5:10
12	5:50	13	5:10	12	5:50	13	5:10
13	5:50	14	5:10	13	5:50	14	5:10
14	5:50	15	5:10	14	5:50	15	5:10
15	5:50	16	5:10	15	5:50	16	5:10
16	5:50	17	5:10	16	5:50	17	5:10
17	5:50	18	5:10	17	5:50	18	5:10
18	7:30	19	5:20	18	5:50	19	5:20
19	8:25	20	5:20	19	5:40	20	5:20
20	9:30	21	5:20	20	5:40	21	5:20
21	10:40	22	5:20	21	5:40	22	5:20
22	11:55	23	5:20	22	5:40	23	5:20
23				23	5:40	23	12:00 M.
24	1:10 A.M.	24	5:20	24	5:40	24	12:00
25	2:20	25	5:20	25	5:40	25	12:00
26	No light.	26	No light	26	5:30	26	12:00
27	No light.	27	No light.	27	5:30	27	12:00
28	No light.	28	No light.	28	5:30	28	12:00
29	5:30 P.M.	29	7:20 P.M.	29	5:30	29	12:00
30	5:30	30	7:55	30	5:30	30	12:00
31	5:30	31	8:40	31	5:30	31	12:00
Total hours lighting, 195 30.				Total hours lighting, 267.40.			

Meeting of the American Institute of Electrical Engineers.

The first session of the Engineers in their new home at 12 West Thirty-first street was held on Wednesday, the 16th, and the business transacted was of more than usual importance. The principal objects of the meeting were to receive the report of the Committee on Wiring with reference to a standard of resistances for commercial copper, and to take action on the resolutions presented at the last spring meeting by Prof. Crocker. Prof. W. A. Anthony, president, was in the chair, and after the formal opening of the meeting Prof. Crocker, as chairman of the committee referred to, arose and made his report. It is now well known that between the wiring tables based on the results obtained by Dr. Matthiessen there are discrepancies, evidently the result of something more than accidental errors.

On placing these down, it became evident that the confusion arose from the use of two separate standards established by Matthiessen at different times—one of them based on the resistance of a mile of copper wire one-sixteenth of an inch in diameter, the other founded on the resistance of a wire in heat alone, and weighing one grain. The committee had determined, after careful investigation, that the latter standard was the one in which the greater reliance could be placed, and presented a series of values based upon this and expressing the resistance of copper wire in terms more convenient for practical use. Although recognizing the fact that Matthiessen's copper was not pure, so that specimens sometimes show specific conductivity over 100 per cent. of his standard, the committee considered it unadvisable to attempt the formation of a normal standard resistance based on perfectly pure copper, for the reason that it would not be any more convenient for practical purposes if it were found, and because the closeness of average commercial wire to the Matthiessen standard renders computation more convenient. A lively discussion followed concerning the advisability of putting out a standard value for the hard copper used by Matthiessen as well as his deductions for annealed copper, and the Institute finally decided to base the standard resistances given out on the soft copper alone as the more definite and generally used material.

The question of American names for electrical units was then formally taken up, and the sentiment of the Institute was unanimously expressed that the practical unit of self-induction should be called the henry, after the great discoverer of the phenomenon. The suggestion, made some months ago, has already been received most favorably, and the present formal action of the Institute was an endorsement of the general sentiment on the part of the electrical public. A practical unit of self-induction is badly needed, and the name proposed is certainly the most fitting that could be found. Any abbreviation of the name was strongly objected to by the Institute, and in response to a general feeling that the practical unit should be some convenient submultiple of the quadrant, a committee was appointed for the purpose of selecting the most available magnitude for this practical unit, to which the name henry should be applied. This committee was ordered to report at the next succeeding meeting, so that the resolutions concerning the name and the magnitude may be closely linked. The only other business transacted at the meeting was the appointment of a committee to co-operate with a committee appointed at the last convention of the National Electric Light Association to report a proper basis for the rating of incandescent lamps, with a view to securing uniformity of practice among manufacturers and users.

Electrical Engineering at the Massachusetts Institute of Technology.

The Massachusetts Institute of Technology was one of the very earliest institutions to take up instruction in practical electrical engineering. At the time the course was established, in 1882, there were but two or three places in the world where a young man could obtain a proper training for a professional career as an electrical engineer. To be sure, at several institutions of learning in this and other countries, there had already been formed a course of instruction in general electrical science, including theoretical electricity and some of the problems of engineering; but none of these, at that time, embraced thorough and careful instruction in all the general principles that underlie electrical engineering, together with a full course in mechanical engineering and the applications of electricity.

It was, however, very evident that with the rapid growth of the electrical industry, and the increasing use of the telephone, electric light and electric power, that there was an excellent professional opening for young men who were neither purely mechanical engineers, or, on the other hand, electricians, knowing little of the principles of machinery or of dynamics, which are necessary in handling problems which come before the electrical engineer. At the suggestion of Prof. Cross the subject was taken up by the authorities of the Institute, and, at the beginning of the academic year of 1882–3, a course in electrical engineering was opened. The Rogers Laboratory of Physics, which had already been in full and useful service, and was thoroughly equipped for an elaborate course in electrical engineering, furnished an admirable basis for the formation of a course which should embody both mechanical and electrical training.

As it was quite evident that such a course could not find proper students at once, it was only opened from the beginning, and no students were received into the higher classes, so that during that academic year there were only students of electrical engineering in the sophomore class. In the succeeding year the course was in force in two classes, but not until 1884–5 was there a full course, extending through the three years of academic course. Only eight students began the course during the first year, but its growth since that time has been a very gratifying evidence of success.

In laying out the course, the starting point was that proposition which has since been so forcibly expressed by Sir William Thomson—an electrical engineer must be both a mechanical engineer and an electrician. As a consequence of this policy, a large amount of time and study was spent in applied mechanics and mechanical engineering; while, hand in hand with this, was carried on a thorough course in the elementary theory of electricity and in acquiring a practical laboratory knowledge of the principles and methods of physical and electrical measurements.

The course in electrical engineering at present covers four years. During the first year, as in all other courses in the institute, the student is engaged in a general study of mathematics, chemistry, drawing, modern languages and various English branches. To enter the course of electrical engineering a special degree of excellence in mathematics and chemistry is required as a prerequisite. At the beginning of the sophomore year the various courses begin to diverge, and those students who will follow electrical engineering assume a study of physics, both in the lecture room and in the physical laboratory, mechanism, analytical and descriptive geometry and calculus. There is also a considerable amount of instruction in wood and metal work in the workshops. In the succeeding year the more characteristic engineering studies are introduced, and the course begins to separate from that in mechanical engineering as far as the study of physics is concerned. The principal work of the year is theoretical electricity, and the laboratory study of electrical measurements, while on the engineering side of the subject, applied mechanics, thermo-dynamics, strength of materials and laboratory work in mechanics and mechanical engineering occupy most of the time, although the pure mathematical studies are carried to a certain extent through this year also.

In the last year the technical application of electricity forms the chief subject of study. An elaborate course of lectures on the subject is presented, and laboratory investigations bearing directly upon the practical problems are carried on throughout the year. So far as is possible the practical instruction is turned in the direction of producing a working knowledge of the details of modern applications of electricity. Special branches of investigation are photometry, dynamo and motor testing, and the somewhat complicated problems that arise in the modern construction of telegraph and telephone lines, particularly in reference to underground work. In the more theoretical side of the student's work he takes up differential equations, the theory of least squares, and, if he desires, the more abstruse portions of theoretical electricity and pure and applied mathematics.

The same laboratory work is continued in the mechanical engineering department, more especially with reference to steam engines and other prime movers, so that the course may be in a certain sense regarded as mechanical engineering, plus a pretty thorough equipment in electricity.

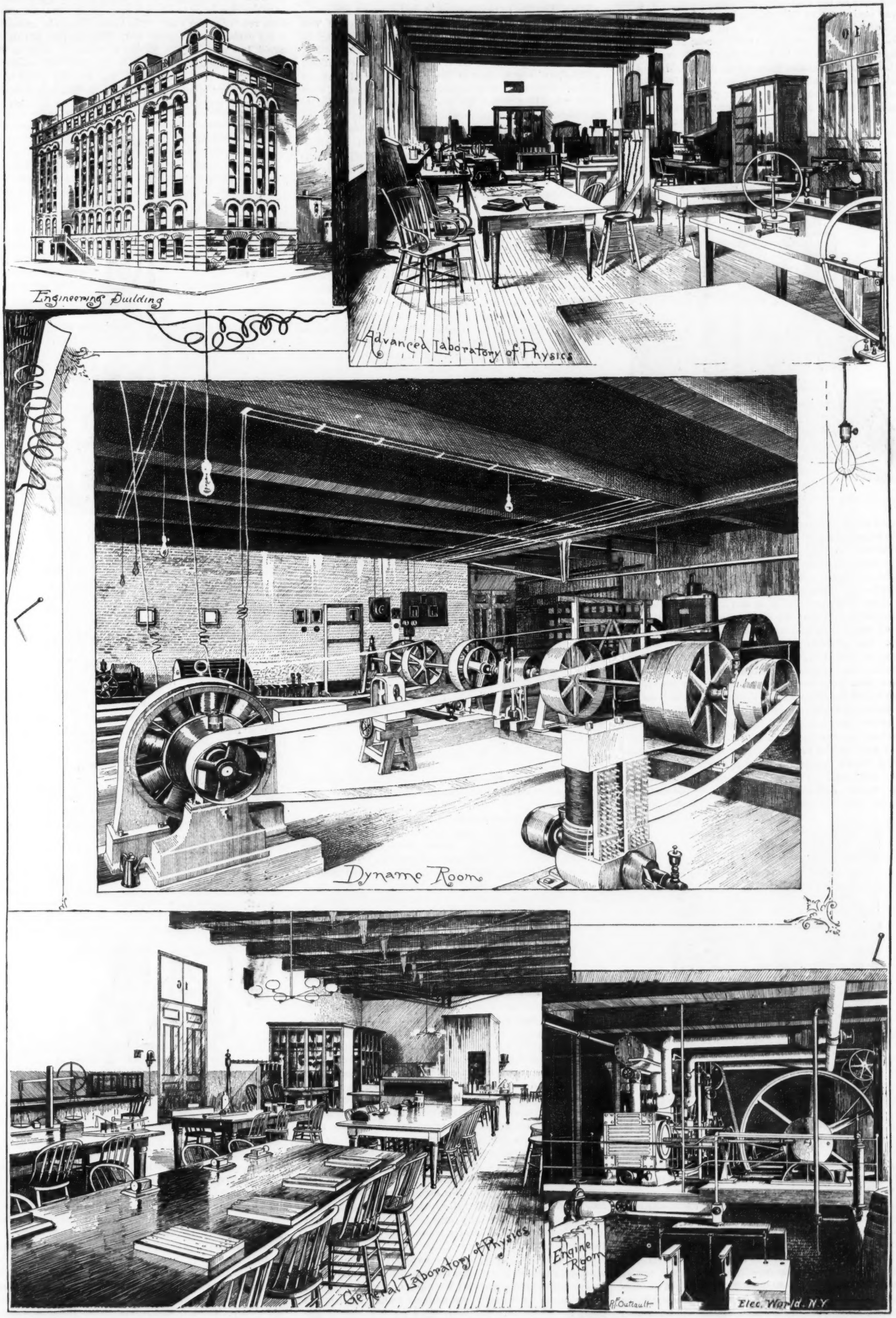
During the last term of the senior year each student is required to write a thesis, based upon original investigations, on some electrical subject. This sometimes involves really valuable results, and care is taken to secure thorough and exact work. The special investigation leading to the thesis is always carried on under the direct guidance of the instructors; but, so far as possible, the student is allowed to use his own methods and work on his own responsibility. The results obtained by these thesis investigations have been, on the whole, very satisfactory. They have made distinct additions to our knowledge of electrical subjects, and a large part of them have been reprinted in all the various scientific journals. More than a dozen of the theses have thus been published, very many of them in the proceedings of the American Academy of Arts and Sciences.

At the present time the equipment of the Institute for the course in electrical engineering is very satisfactory. The equipment of the laboratories for electrical engineering is excellent. It includes all the important forms of laboratory and commercial testing apparatus, and instruments specially adapted for special researches in electricity and magnetism. The dynamo room is well fitted, and the facilities here for instruction have been greatly increased by the recent gifts of the Edison plant, a 150-light dynamo from Mr. Edison, and a 9,600 watt constant potential dynamo from the Thomson-Houston Electric Company, during the last year. A 500-light Thomson-Houston alternator, with a full complement of converters, was also added to the dynamo room. A 500-light United States direct current dynamo is used for the purpose of lighting the engineering building, and will, of course, be available for the purpose of instruction, and, aside from this, Boston has now become so thoroughly equipped electrically, in many ways, the facilities for students for examining and investigating the different electrical systems and methods are specially good.

The engineering building, recently erected, has greatly aided instruction, in both mechanical and electrical engineering. The increased room available, and the power of operating heavy machinery here with entire freedom, has done much to facilitate work in all the engineering departments. In the engineering building is a 150 h. p. triple expansion engine, especially arranged for experimental purposes. It is of the Reynolds-Corliss type, with cylinders of 30-inch stroke, and 9, 16 and 24 inches diameter respectively; and so constructed that it can be run either single, compound, or triple expansion, with every possible variety of combination. This example of the most modern type of steam engine gives opportunities for studying and research of the progress of steam engineering, which proves such an important factor in the education of an electrical engineer. The corps of instructors is large, considering the number of students. Seven members of the academic staff devote their entire time to the work in electrical engineering, and aside from the regular course of instruction special teaching is given by gentlemen who are professionally engaged in various departments of electrical engineering, or especially conversant with various branches of applied electricity. During the past year a large number of special lectures of this sort have been given by well known experts, and a vast amount of valuable information thus added to the regular routine of the course. As the course in electrical engineering now stands, it will be found to cover pretty thoroughly the modern applications and methods, as well as the more theoretical portion of the subject.

From its very beginning the course of electrical engineering has been a successful one. Its graduates have usually obtained satisfactory positions almost immediately after completing the course, and their record since then has shown that the training received has been of substantial benefit to their future career. Year by year the number of students has increased, steadily and rapidly. The number of graduates during the years since the establishment of the course has been as follows: 1885, two; 1886, ten; 1887, eight; 1888, seventeen; 1889, seventeen; 1890, eighteen. The total number of students connected with the department of electrical engineering as candidates for a degree shows an even greater rate of increase. This has been as follows: 1882–3, seven; 1883–4, eighteen; 1884–5, thirty; 1885–6, forty-one; 1886–7, fifty-two; 1887–8, sixty-one; 1888–9, seventy-seven; 1889–90, ninety-one. Of the graduates, up to the present time, a large portion are now in the service of some electrical company, or in other ways pursuing their professional calling as electrical engineers, although not a few have so far seen the advantage of thorough training as to still further pursue their electrical studies.

The encouragement received from electricians at large in the organization and operation of this course of training has been most gratifying. Some of the leading electrical companies have taken keen interest in the operation of the course, and have in many substantial ways helped on the work. There seems to be now the feeling that electrical education, being, as it is, the basis of future progress in electrical engineering, should be cordially encouraged by every one who is interested in the practical development of electricity, and, as time goes on, the call for trained men and the appreciation of the advantage of electrical study must assuredly increase. At the present time the electrical engineer has professional opportunities that are accorded to few lines of work, and it is a great satisfaction to feel that the efforts of the various institutions engaged in giving electrical training are thoroughly appreciated.



ELECTRICAL ENGINEERING LABORATORIES OF THE MASSACHUSETTS INSTITUTE OF TECHNOLOGY.

A Successful Electric Headlight.

Grumblers to the contrary notwithstanding, the great railway companies of this country are quick to take advantage of any improvements which will facilitate the safe and easy running of trains over their roads; and no better example of this could be found than the prompt way in which railway authorities have taken up the idea of an electric headlight and have put into extensive use the variety of this apparatus that we take pleasure in illustrating in these pages. There are two distinct views of the function of a headlight. It may be looked upon, as it is to a very large extent abroad, as simply a signal light for the

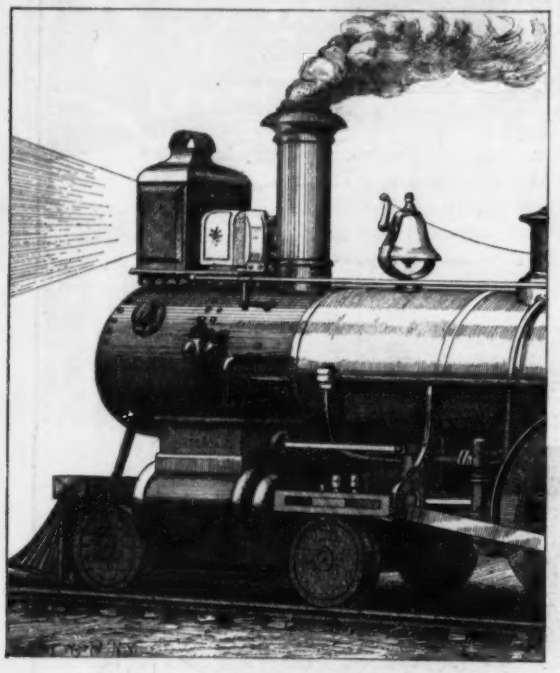


Fig. 1.—Electric Headlight Plant in Position.

benefit of track and station men; or, on the other hand, it may be regarded as an illuminator intended to show possible obstacles on the track at a sufficient distance to enable the stopping of the train without the disastrous results of a collision.

There is a well-known popular theory that the headlight is not of much use to an engineer anyhow, and if we consider the ordinary forms of reflector lamp now in use it is not at all improbable that such a theory of inefficiency is correct. It is tolerably evident that for the headlight to be of any service in showing obstacles on the track, it must be capable of rendering them distinctly visible at a distance so great that a train at ordinary speed can be readily stopped before it reaches them. A headlight which merely shows the track a few rods in front of the engine can do little toward averting a collision, provided the train is running anywhere near the usual speed. Of course any headlight is serviceable as a signal to trainmen or other employés of an approaching locomotive; but to render it of any real value in assisting the engineer in his watch and thus protecting the passenger on the flying train against the perils of track obstruc-

Fig. 2.—Pyle Engine for Headlight.

tion, it must be possessed of sufficient power to penetrate the blackness of night a long distance in front of the locomotive. It is for this reason, probably, that the headlight had fallen into disrepute as an assistant to the engineer until the advent of the present apparatus. As train speeds increase the headlight must naturally be more and more powerful in order to produce any useful effect, and the usual oil lamp is wholly incapable in any practical form of giving a sufficiently penetrating beam. It is to the use of electricity, therefore, that we must look for a light of sufficient power to show plainly the condition of the track for a long distance in front of the train. The present apparatus has been put into practical use on several roads, and the results of experiments have been most gratifying. It is the invention throughout of Mr. G. C. Pyle, of Indianapolis, and is operated by the National Electric Headlight Company, of Indianapolis, Ind.

The difficulties to be overcome in designing an apparatus of this kind were numerous. In the first place, it was necessary to have an electric light plant small enough to be readily placed somewhere on or about the locomotive, and simple enough to be cared for by the engineer without adding any great amount of labor to his already arduous duties. It must be very unlikely to get out of order, even when roughly handled, for the usefulness of the electric headlight depends on its reliability. Then, aside from the generating apparatus, the lamp must work steadily and smoothly, even when subject to the extraordinary vibration experienced on a rough track. This difficulty was really the most serious one to overcome, and it was the difficulty which has stood in the way of all previous attempts at an electric headlight. Besides being reliable, the lamp must be easily managed, even by unskilled attendants, and be very unlikely to fail in any way.

Taking up the apparatus in detail, the general appearance of the complete system is shown in Fig. 1, where we have the little dynamo and engine located between the smokestack and the headlight operated by them The engine is one of the multiple cylinder class which is found of such considerable use for direct coupling to machinery of various kinds. It is, as befits an engine to operate a single arc light, very small, perhaps the smallest engine complete and perfect in all its parts that has ever been put to practical use. Its full output is only about 3 h. p., and a three-quarter inch pipe is ample to supply the steam which is taken from the back end of the boiler, so that the throttle is always within easy reach of the engineer. Like the rest of the apparatus, the engine is the invention of Mr. Pyle, and, as will be seen from Fig. 2, has four cylinders

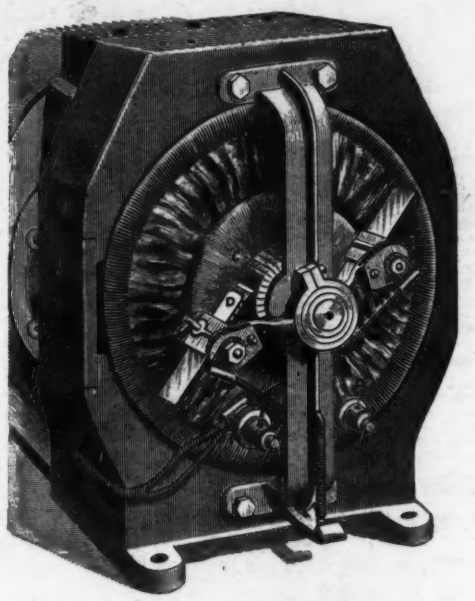


Fig 3.—Arc Dynamo.

completely encased, so that the running parts will be free from dust and dirt which might be liable to interfere with their action.

This minute engine is connected directly to the armature spindle of a diminutive dynamo, shown in Fig. 3, designed, as will be seen, in the most compact fashion, and capable of being with the engine completely shut in from any interference of flying cinders or dirt. The construction of the dynamo is quite evident from the cut. Designed as it is to supply only a single arc lamp, no special regulation is necessary, and really the only care required is to keep the bearings oiled and the brushes, which need never be shifted, trimmed and smooth. The care required is then very slight, and it is found in practice that the additional labor imposed by the headlight apparatus is very trifling and that engineers are glad to go to the small necessary trouble for the sake of the immense advantage gained by the powerful headlight. The total weight of the engine and dynamo together is but 650 pounds, and the combination occupies a space 28 inches long, 15 inches wide and 17 inches high. The normal speed is 425 turns per minute.

In fitting the apparatus to a locomotive, the headlight is usually moved forward a little to secure the necessary space between it and the stack for the location of the machinery. It will be noticed that the entire plant is under complete control from the cab, as a single turn of the valve in a supply pipe will start up the light or extinguish it when running. It can be turned on even more readily than gas could be. The lamp used in this system is shown in Figs. 4 and 5. It belongs to the rack-feed style of lamp and is operated in the very simplest manner by the ratchet device shown clearly in Fig. 5. The carbons run, as is evident from Fig. 4, in guides, thus steadying them at a point quite close to the arc, so that any vibration of the engine will not jar the carbons sufficiently to break them or to destroy the continuity or uniformity of the arc. The new carbons are readily put in by lifting the rod and carbon holder clear up, catching the pole on the ratchet wheel and then entering the carbons through the guides into their holders. Unloosing the pawl until the carbons touch, the lamp is ready for operation. The hand nuts on the base of the lamp allow loosening it so that it can be moved sufficiently to focus it properly. The set screw and lifting screw at the base of the lamp serve to raise the apparatus into its proper focus in a vertical plane. The entire lamp can be removed from the headlight case very easily in case it is necessary to make repairs or to clean it more carefully than can be done readily in the case. The lower electrode, instead of being carbon, is a copper rod. The purpose of this is to avoid the necessity of having a focusing lamp, as that form of apparatus is usually complicated and nearly always liable to get out of order. The wasting away of the copper is very gradual, and when it becomes wasted or blunt, so as not to give the best results, it can be taken out,

Fig. 4.—Pyle Headlight Lamp.

filed down and put back in very nearly the same place as before. This arrangement of work between carbon and copper gets rid very effectively of the difficulties of focusing and lessens by a considerable amount the care required to operate the lamp. The light given is nominally 2,000 c. p. and proves amply sufficient for present railway usage, although, of course, the power could be largely enhanced if it were desirable.

The tests which have been made of this apparatus have been exceedingly gratifying. The experiments with the electric headlight have been going on several years, but at present it has passed the experimental stage, and passed into regular use on a considerable number of roads. Lights are now regularly employed on the Vandalia; Cincinnati, Hamilton & Dayton; Indianapolis, Decatur & Western; Wabash; Michigan Central; Columbus, Hocking Valley & Toledo, Louisville, New Albany & Chicago and Milwaukee, Lake Shore & Western roads. On more than one of these a large number of lights are in operation. No better idea of the efficiency of the apparatus need be given than that which is evident from Fig. 6, which shows the appearance of the electric headlight in use. It is a fac simile of a photograph taken on the road, and a careful examination shows readily enough the immense power and penetration of the electric beam. A dozen or fifteen telegraph poles in front of the engine can be distinguished regularly, even when the weather is not altogether good, and on an exceptionally clear night as many as 33 poles have been counted from the cab of the engine illuminated

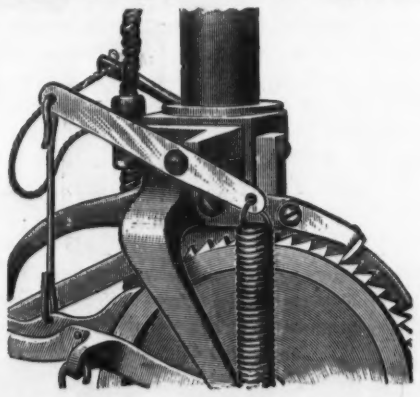
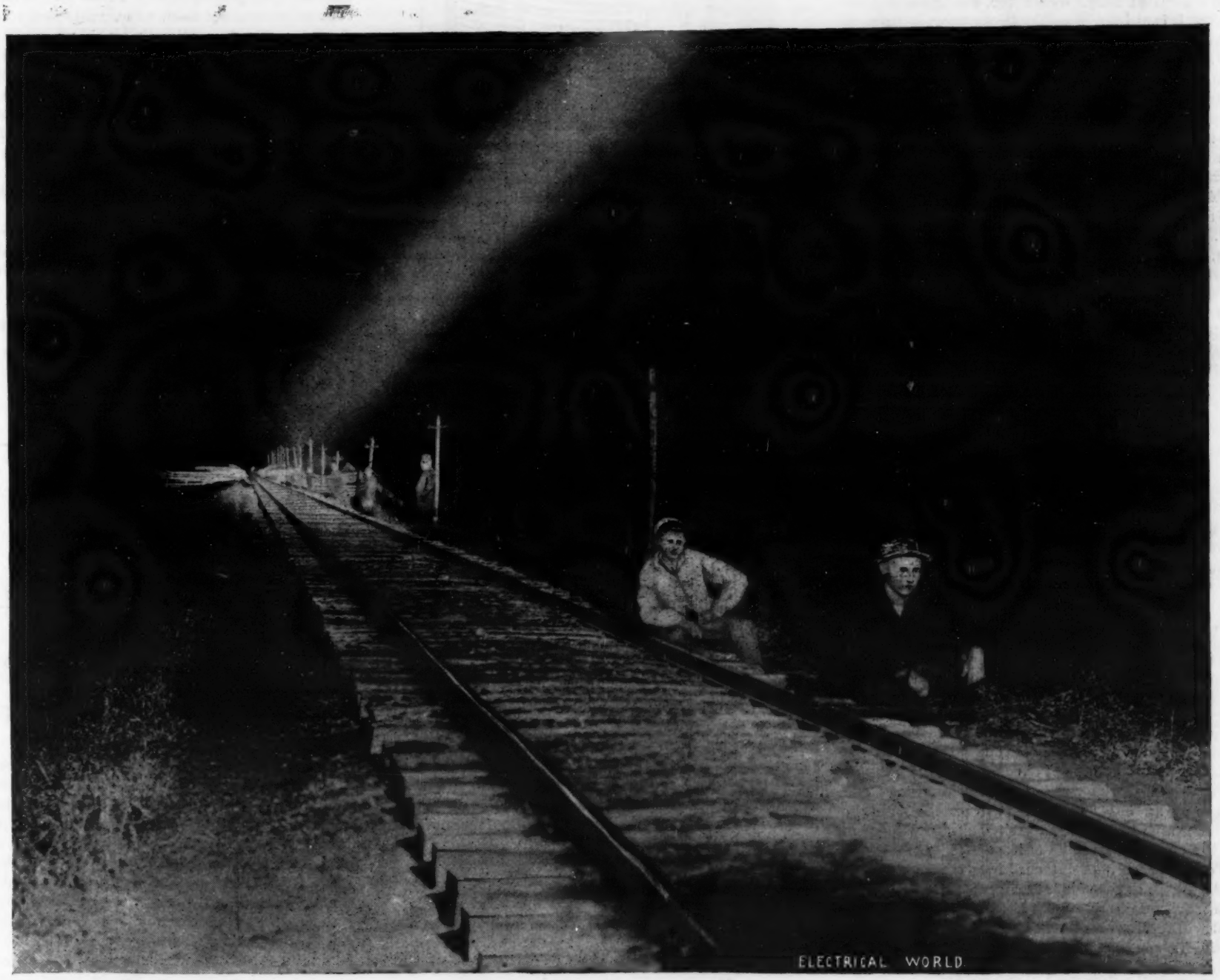


Fig. 5.—Details of Pyle Lamp.

by the powerful light. When we remember that the poles are about 29 or 30 to the mile, some adequate idea of the power of the electric headlight to show details at a long distance in front of the engine may be gathered. Even in bad weather, when the illuminating power of the lamp could not fairly be expected to be anywhere near its maximum, the view for 1,000 or 1,200 feet ahead of the engine is substantially as good as in daylight. Small obstructions on the track could readily be made out at that distance, even by an inexperienced eye, while a great or large object would be easily visible nearly half a mile. In clear weather much better results can be reached, and the cases are very few where a storm or fog would be dense enough to limit the field of view to a dangerously short space. An engineer familiar with his road

would undoubtedly make out, even in the darkest night, all details of the track necessary for safe running, and it could hardly happen that the beam from the headlight would fail to penetrate far enough to make it easy for the train to be stopped in case of an obstacle being observed. Sitting in the cab of an engine provided with this headlight is a decidedly new sensation. Small objects like mile posts can be readily seen at a distance of a mile in good weather, and even the joints in the rails can be seen 700 feet ahead.

In addition to its other virtues, the cost of the headlight apparatus is comparatively little—quite inconsiderable compared with the advantages to be gained from its use. A single collision from an obstacle looming up before an engine far too near to allow of stopping would oftentimes cost a company more than a complete equipment of the electric headlights which render such accidents very improbable. The only objection which might be raised to the use of an apparatus of this kind is that which has been advanced against the electric light before by pilots. Running toward a powerful light of this kind on a double track, it might sometimes be a little difficult to distinguish landmarks by reason of the glare; but even the ordinary headlight is somewhat objectionable in this respect, and it is quite certain that additional range gained by the use of electricity will more than compensate for any additional glare. The case is much more favorable at least than that met with by pilots, because, although there is an intensely brilliant light from the approaching engine, yet the driver's own machine is casting forward a beam of equal intensity, making the track ahead as bright as day for a long distance. Experiments on the Cincinnati, Hamilton & Dayton, where the headlights are used on 40 miles of double track have shown practically that there is not the least actual difficulty from this cause. The whole apparatus seems admirably fitted to accomplish the end for which it was designed, and it is a pleasure to record the uniform success of all the experiments and the general favor with which a device so useful to the safety of the traveling public has been received by the railroad companies.



THE ELECTRIC HEADLIGHT IN OPERATION.

Long Life of Some Series Incandescent Lamps.

We have received from Mr. C. Guirkin, of Elizabeth City, N. C., some interesting details of some remarkably durable incandescent lamps. Mr. Guirkin says:

"Having read with considerable interest the several articles that have appeared in your valuable journal on the 'Long Life of Incandescent Lamps,' and, acting on your suggestion, would beg to give some results of my experience with series incandescent lamps, having installed a good many in the past few months. In February last I placed on the circuits of the Electric Light and Power Company, of this place, 250 30 c. p. 10 ampère series lamps, of the Bernstein make, and up to Sept. 18 there have been less than 30 renewals; the lamps now having shown a record of over 1,500 hours burning, without any signs of giving out. In very rare instances did any of the 30 lamps that were renewed show less than 600 hours life. These lamps were run on circuits carrying a 10 ampère current, and were never run below that, which shows a pretty good record. I would like to hear from any other users of series lamps as to the life they are getting with their lamps."

The Effect of Direct and Alternating Pressures on the Human Body.*

BY J. SWINBURNE.

As there seems to be some doubt as to the relative effects of alternating and direct currents, a bridge which measured the resistance of the patient under various pressures was made up. Fuller readings, which agreed with the first as nearly as such very uncertain readings can be expected to agree, were afterwards taken by putting on different pressures and measuring the current, the resistances being calculated. The alternating currents were measured with a non-inductive wattmeter arranged as an ammeter, the pressure being taken with a hot wire voltmeter. The tests were taken from hand to hand, the hands being dry or wet with dilute acid in the case of direct currents, and dry in the case of alternating. It seemed to make little difference in the case of alternating currents whether the hands were wet or dry. There was no need to measure the resistance from hand to foot, as that obviously would depend on the boots worn.

In the following table the direct pressure is always 50 volts. Any of those tested could have taken more than this; but even with 50 volts the discomfort is extreme if the contact is made and broken. The maximum current taken was .04 ampère by *E*, whose resistance is low. He could have taken more if available. All the resistances are much lower than those obtained by the usual method of measuring with a bridge and one or two cells. Probably polarization then interferes.

When the direct current from 50 volts is concentrated in one finger it feels hot, though, especially as the current is reduced, there can be no appreciable heat generated.

HUMAN RESISTANCES; HAND TO HAND.

Current.	Name.	Hands.	Volts.	Resistance.
Alternate	A	Dry.	18	930
Continuous	"	Dry.	50	8,000
Continuous	"	H_2SO_4.	50	3,010
Alternate	B	Dry.	10	1,330
Alternate	"	Dry.	18	1,110
Continuous	"	Dry.	50	6,660
Continuous	"	H_2SO_4.	50	1,930
Alternate	C	Dry.	18	620
Continuous	"	Dry.	50	5,400
Continuous	"	H_2SO_4.	50	1,920
Alternate	D	Dry.	18	1,090
Continuous	"	Dry.	50	10,000
Continuous	"	H_2SO_4.	50	16,000
Continuous	E	Dry.	50	6,700
Continuous	"	H_2SO_4.	50	1,100
Alternate	"	Dry.	18	1,300
Alternate	F	Dry.	18	750
Continuous	"	Dry.	50	3,320
Continuous	"	H_2SO_4.	50	1,710
Alternate	"	Dry.	54	670

The most curious thing is the very low effective resistance to alternating currents. The alternating pressure could be regulated by steps of 4.5 volts. Out of the five subjects tested not one except *F* could stand more than 18 volts alternating, the maximum effective current taken being 0.3 ampère. *F* seems abnormal. He took 54 volts and nearly a tenth of an ampère. *D*, who has the highest resistance, was the only lady tested. Though with the exception of *F*, none of us could take more than 18 volts alternating with a good contact, I have several times touched 600-volt alternating terminals lightly. They were given by a Siemens machine used for "flashing" lamps. Before I took charge of the factory containing it I am told several of the girls had shocks from the same machine. Spring switches, which demanded both hands to give any current, obviated danger to them afterward. I have also had a very severe shock from a 100-volt Ferranti. Though 18 volts was as much as we could take, there was no difficulty in letting go.

These results bear out those of Messrs. Lawrence and Harries† as to the relative resistance to alternating and direct currents, but the figures are entirely different. They never found any one take over 10 milliampères, while *F* took 90 milliampères alternating, and *E*, a workman, took 44 milliampères direct, and could have taken far more if available.

* Paper read before the British Association in Section A, Leeds, September, 1890.

† *Jour. Inst. Elec. Eng.*, XIX., No. 86. THE ELECTRICAL WORLD, April 26, 1890.

The Electromagnet.*

BY PROF. SILVANUS P. THOMPSON, D. SC., B. A., M. I. E. E.

GENERALITIES CONCERNING ELECTROMAGNETS.

Materials.—In any complete treatise on the electromagnet it would be needful to enumerate, and to discuss in detail, the several constructive features of the apparatus. Three classes of material enter into its construction—first, the iron which constitutes the material of the magnetic circuit, including the armature as well as the cores on which the coils are wound, and the yoke that connects them; secondly, the copper which is employed as the material which conducts the electric currents, and which is usually in the form of wire; thirdly, the insulating material employed to prevent the copper coils from coming into contact with one another, or with the iron core. There is a further subject for discussion in the bobbins, formers, or frames upon which the coils are in so many cases wound, and which may in some cases be made in metal, but often are not. The engineering of the electromagnet might well furnish matter for a special chapter.

TYPICAL FORMS.

It is difficult to devise a satisfactory or exhaustive classification of the varied forms which the electromagnet has assumed, but it is at least possible to enumerate some of the typical forms.

1. *Bar Electromagnet.*—This consists of a single straight core (whether solid, tubular, or laminated), surrounded by a coil. Fig. 3 (p. 156) depicted Sturgeon's earliest example.

2. *Horseshoe Electromagnet.*—There are two sub-types included in this name. The original electromagnet of Sturgeon (Fig. 1) really resembled a horseshoe in form, being constructed of a single piece of round wrought iron, about half an inch in diameter, and nearly a foot long, bent into an arch. In recent years the other sub-type has prevailed, consisting, as shown in Fig. 11, of two separate iron cores, usually cut from a circular rod, fixed into a third piece of wrought iron, the yoke. Occasionally this form is modified by the use of one coil only, the second core being left uncovered. This form has received in France

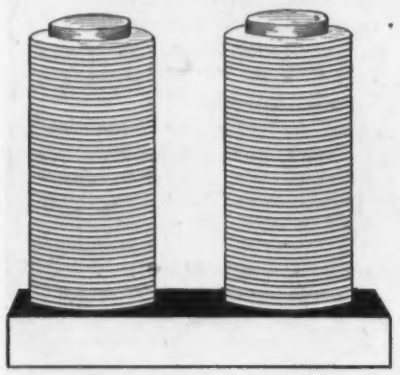


FIG. 11.—TYPICAL TWO-POLE ELECTROMAGNET.

the name of *aimant boîteux*. Its merits will be considered later. Sometimes a single coil is wound upon the yoke, the two limbs being uncovered.

3. *Iron-clad Electromagnet.*—This form, which has many times been re-invented, differs from the simple bar magnet in having an iron shell or casing external to the coils and attached to the core at one end. Such a magnet presents, as depicted in Fig. 12, a central pole at one end surrounded by an outer annular pole of the opposite polarity. The appropriate armature for electromagnets of this type is a circular disc or lid of iron.

4. *Coil and Plunger.*—A detached iron core is attracted into a hollow coil, or solenoid, of copper wire, when a current of electricity flows round the latter. This is a special form, and will receive extended consideration.

5. *Special Forms.*—Beside the leading forms enumerated above, there are a number of special types, multipolar, spiral, and others designed for particular purposes. There is also a group of forms intermediate between the ordinary electromagnet and the coil and plunger form.

POLARITY.

It is a familiar fact that the polarity of an electromagnet depends upon the sense in which the current is flowing around it. Various rules for remembering the relation of the electric flow and the magnetic force have been given. One of them that is useful is that when one is looking at the north pole of an electromagnet, the current will be flowing around that pole in the sense opposite to that in which the hands of a clock are seen to revolve. Another useful rule, suggested by Maxwell, is illustrated by Fig. 13, namely, that the sense of the circulation of the current (whether right or left handed) and the positive direction of the resulting magnetic force are related together in the same way as the rotation and the travel of a right-handed screw are associated together. Right-handed rotation of the screw is associated with forward travel. Right-handed circulation of a current is associated with a magnetic force tending to produce north polarity at the forward end of the core.

USES IN GENERAL.

As a piece of mechanism an electromagnet may be regarded as an apparatus for producing a mechanical action at a place distant from the operator who controls it, the means of communication from the operator to the distant point where the electromagnet is being the electric wire. The uses of electromagnets may, however, be divided into two main divisions. For certain purposes an electromagnet is required merely for obtaining temporary adhesion or lifting power. It attaches itself to an armature and cannot be detached so long as the exciting current is maintained, except by the application of a superior opposing pull. The force which an electromagnet thus

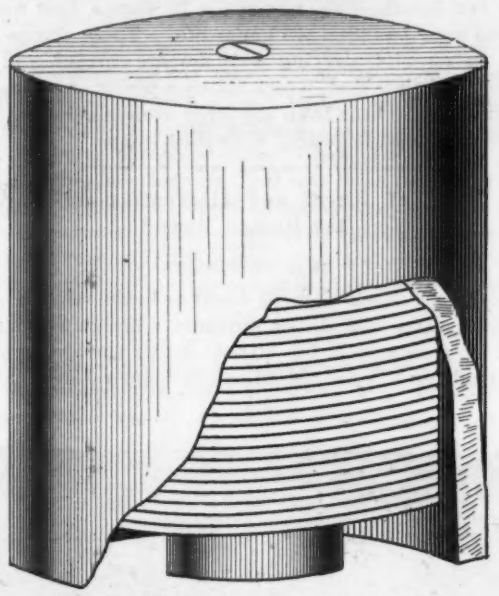


FIG. 12.—IRON-CLAD ELECTROMAGNET.

exerts upon an armature of iron, with which it is in direct contact, is always considerably greater than the force with which it can act on an armature at some distance away, and the two cases must be carefully distinguished. *Traction* of an armature in contact, and *attraction* of an armature at a distance, are two different functions. So different, indeed, that it is no exaggeration to say that an electromagnet designed for the one purpose is unfitted for the other. The question of designing electromagnets for either of these purposes will occupy a large part of these lectures. The action which an electromagnet exercises on an armature in its neighborhood may be of several kinds. If the armature is of soft iron, placed nearly parallel to the polar surfaces, the action is one simply of attraction, irrespective of the polarity of the magnet. If the armature lies oblique to the lines of the poles there will be a tendency to turn it round, as well as to attract it; but, again, if the armature is of soft iron the action will be independent of the polarity of the magnet, that is to say, independent of the direction of the exciting current. If, however, the armature be itself a magnet of steel permanently magnetized, then the direction in which it tends to turn, and the amount, or even the sign of the force with which it is attracted, will depend on the polarity of the electromagnet; that is to say, will depend on the direction in which the exciting current circulates. Hence there arises a difference between the operation of a *non-polarized* and that of a *polarized* apparatus, the latter term being applied to those forms in which there is employed a portion—say an armature—to which an initial fixed magnetization has been imparted. Non-polarized apparatus is in all cases independent of the direction of the current. Another class of uses served by electromagnets is the production of

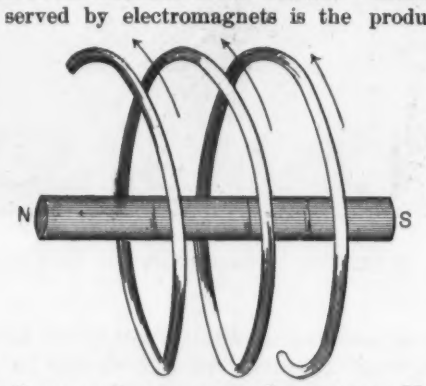


FIG. 13.—DIAGRAM ILLUSTRATING RELATION OF MAGNETIZING CIRCUIT AND RESULTING MAGNETIC FORCE.

rapid vibrations. These are employed in the mechanism of electric trembling bells, in the automatic breaks of induction coils, in electrically-driven tuning forks such as are employed for chronographic purposes, and in the instruments used in harmonic telegraphy. Special constructions of electromagnets are appropriate to special purposes such as these. The adaptation of electromagnets for the special end of responding to rapidly alternating currents is a closely kindred matter. Lastly, there are certain applications of the electromagnet, notably in the construction of some forms of arc lamp, for which it is specially sought to obtain an equal, or approximately equal, pull over a definite range of motion. This use necessitates special designs.

THE PROPERTIES OF IRON.

A knowledge of the magnetic properties of iron of different kinds is absolutely fundamental to the theory and design of electromagnets. No excuse is therefore necessary for treating this matter with some fullness. In all modern treatises of magnetism the usual terms are defined and explained. Magnetism, which was formerly treated of as though it were something distributed over the end-surfaces of magnets, is now known to be a phenomenon of internal structure; and the appropriate mode of considering it is to treat the magnetic materials, iron and the like, as being capable of acting as good conductors of the magnetic lines; in other words, as possessing great magnetic permeability. The precise notion now attached to this word is that of a numerical coefficient. Suppose a magnetic force—due, let us say, to the circulation of an electric current in a surrounding coil—were to act on a space occupied by air, there would result a certain number of magnetic lines in that space. In fact, the intensity of the magnetic force, symbolized by the letter **H**, is often expressed by saying that it would produce **H** magnetic lines per square centimetre in air. Now, owing to the superior magnetic power of iron, if the space subjected to this magnetic force were filled with iron instead of air, there would be produced a larger number of magnetic lines per square centimetre. This larger number in the iron expresses the degree of magnetization in the iron; it is symbolized* by the letter **B**. The ratio of **B** and **H** expresses the permeability of the material. The usual symbol for permeability is the Greek letter μ. So we may say that **B** is equal to μ times **H**. For example, a certain specimen of iron, when subjected to a magnetic force capable of creating, in air, 50 magnetic lines to the square centimetre, was found to be permeated by no fewer than 16,062 magnetic lines per square centimetre. Dividing the latter figure by the former gives as the value of the permeability at this stage of the magnetization 321, or the permeability of the iron is 321 times that of air. The permeability of such non-magnetic materials as silk, cotton and other insulators, also of brass, copper and all the non-magnetic metals is taken as 1, being practically the same as that of the air.

This mode of expressing the fact is, however, complicated by the fact of the tendency in all kinds of iron to magnetic saturation. In all kinds of iron the magnetiz-

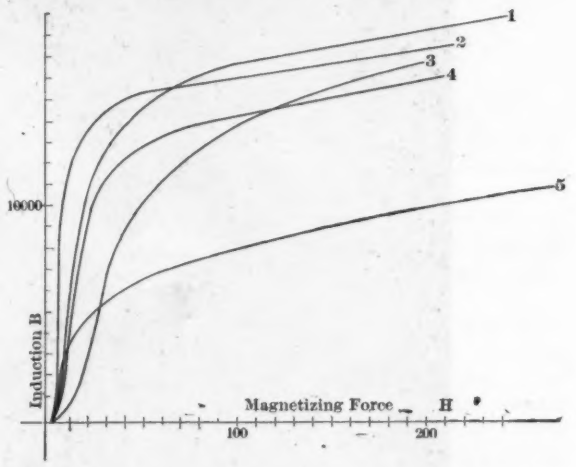


FIG. 14.—CURVES OF MAGNETIZATION OF DIFFERENT MAGNETIC MATERIALS.

1. Very soft steel.
2. Wrought-iron.
3. Oil-hardened steel.
4. Annealed steel.
5. Cast-iron.

ability of the material becomes diminished as the actual magnetization is pushed further. In other words, when a piece of iron has been magnetized up to a certain degree it becomes, from that degree onward, less permeable to further magnetization, and though actual saturation is never reached, there is a practical limit beyond which the magnetization cannot well be pushed. Joule was one of the first to establish this tendency toward magnetic saturation. Modern researches have shown numerically how the permeability diminishes as the magnetization is pushed to higher stages. The practical limit of the magnetization, **B**, in good wrought iron is about 20,000 magnetic lines to the square centimetre, or about 125,000 lines to the square inch; and, in cast iron the practical saturation limit is nearly 12,000 lines per square centimetre, or about 70,000 lines per square inch. In designing electromagnets, before calculations can be made as to the size of a piece of iron required for the core of a magnet for any particular purpose, it is necessary to know the magnetic properties of that piece of iron; for it is obvious that if the iron be of inferior magnetic permeability, a larger piece of it will be required in order to produce the same magnetic effect as might be produced with a smaller piece of higher permeability. Or, again, the piece having inferior permeability will require to have more copper wire wound on it; for in order to bring up its magnetization to the required point, it must be subjected to higher magnetizing forces than would be

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* Cantor Lecture. No. 1, continued from THE ELECTRICAL WORLD, Sept. 6, 1890.

* The following are the various ways of expressing the three quantities which have to be considered:

B—The internal magnetization.
The magnetic induction.
The induction.
The permeation.
The number of lines per square centimetre in the material.

H—The magnetizing force at a point.
The magnetic force at a point.
The intensity of the magnetic force.
The number of lines per square centimetre that there would be in air.

μ—The magnetic permeability.
The permeability.
The specific conductivity for magnetic lines.
The magnetic multiplying power of the material.

necessary if a piece of higher permeability had been selected.

A convenient mode of studying the magnetic facts respecting any particular brand of iron is to plot on a diagram the curve of magnetization—*i. e.*, the curve in which the values, plotted horizontally, represent the magnetic force **H**, and the values plotted vertically those that correspond to the respective magnetization **B**. In Fig. 14, which is modified from the researches of Professor Ewing, are given five curves relating to very soft steel, wrought-iron, oil-hardened steel, annealed steel and cast-iron. It will be noticed that all these curves have the same general form. For small values of **H** the values of **B** are small, and as **H** is increased **B** increases also. Further, the curve rises very suddenly, at least with all the softer sorts of iron, and then bends over and becomes nearly horizontal. When the magnetization is in the stage below the bend of the curve, the iron is said to be far from the state of saturation. But when the magnetization has been pushed beyond the bend of the curve, the iron is said to be in the stage approaching saturation; because at this stage of magnetization it requires a large increase in the magnetizing force to produce even a very small increase in the magnetization. It will be noted that for soft wrought iron the stage of approaching saturation sets in when **B** has attained the value of about 16,000 lines per square centimetre, or when **H** has been raised to the value of about 50. As we shall see, it is not economical to push **B** beyond this limit; or, in other words, it does not pay to use stronger magnetic forces than those of about **H** = 50.

METHODS OF MEASURING PERMEABILITY.

There are four sorts of experimental methods of measuring permeability.

1. *Magnetometric Methods.*—These are due to Müller, and consist in surrounding a bar of the iron in question by a magnetizing coil and observing the deflection its magnetization produces in a magnetometer.

2. *Balance Methods.*—These methods are a variety of the preceding, a compensating magnet being employed to

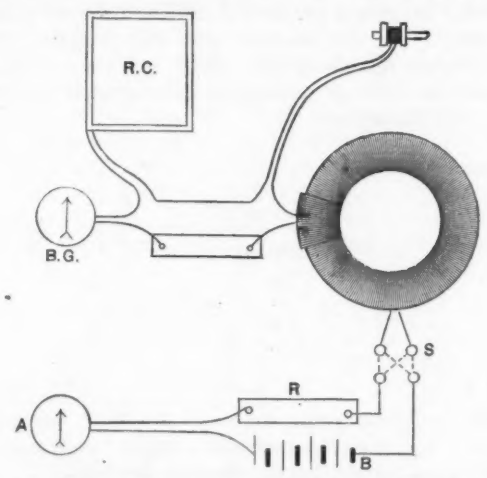


FIG. 15.—RING METHOD OF MEASURING PERMEABILITY (ROWLAND'S ARRANGEMENT).

balance the effect produced by the magnetized iron on the magnetometric needle. Von Feilitzsch used this method, and it has received a more definite application in the magnetic balance of Professor Hughes. The actual balance is exhibited to-night upon the table, and I have beside me a large number of observations made by students of the Finsbury Technical College by its means upon sundry samples of iron and steel. None of these methods are, however, to be compared with those that follow.

3. *Inductive Methods.*—There are several varieties of these, but all depend on the generation of a transient induction current in an exploring coil which surrounds the specimen of iron, the integral current being proportional to the number of magnetic lines introduced into, or withdrawn from, the circuit of the exploring coil. Three varieties may be mentioned.

(*A*) *Ring Method.*—In this method, due to Kirchhoff, the iron under examination is made up into a ring, which is wound with a primary or exciting coil, and with a secondary or exploring coil. Determinations on this plan have been made by Stowletow, Rowland, Bosanquet and Ewing; also by Hopkinson. Rowland's arrangement of the experiment is shown in Fig. 15, in which B is the exciting battery; S, the switch for turning on or reversing the current; R, an adjustable resistance; A, an ampèremeter; and $B\,G$ the ballistic galvanometer, the first swing of which measures the integral induced current. $R\,C$ is an earth inductor or reversing coil wherewith to calibrate the readings of the galvanometer; and above is an arrangement of a coil and a magnet to assist in bringing the swinging needle to rest between the observations. The exciting coil and the exploring coil are both wound upon the ring: the former is distinguished by being drawn with a thicker line. The usual mode of procedure is to begin with a feeble exciting current, which is suddenly reversed, and then reversed back. The current is then increased, reversed and re-reversed; and so on, until the strongest available points are reached. The values of the magnetizing force **H** are calculated from the observed value of the current by the following rule. If the strength of the current, as measured by the ampèremeter, be i, the number of spires of the exciting coil S, and the length, in centimetres of the coil (*i. e.*, the mean circumference of the ring) be l, then **H** is given by the formula:

$$\mathbf{H} = \frac{4\pi}{10} \times \frac{S\,i}{l} = 1.2566 \times \frac{S\,i}{l}$$

Bosanquet, applying this method to a number of iron rings, obtained some important results.

On the Electro-Dynamics of Stationary Bodies.*

BY H. HERTZ.

It will be noticed from the expression already given for the electro-magnetic energy that the quantities X, Y, Z, L, M, N have been defined in such a way as to have their physical dimensions the same for each. It follows from (1) and (2) that if we regard μ and ε as simple numbers, the quantity A is the inverse of a velocity. This quantity is, in fact, a constant of the ether itself, and does not depend on the existence of other bodies.

Multiply the equations given in (1) and (2) by L, M, N, X, Y, Z, respectively, add them together, and multiply the resulting equation by $\frac{1}{4\pi A}\,d\tau$, when $d\tau$ is an element of volume. Integrate throughout a space bounded in any given manner, and let the normal to one of the surface elements, $d\omega$, make with the axes the angles (n, x), (n, y), (n, z). When the integration is performed, we obtain

$$\left.\begin{aligned} &\frac{d}{dt}\int \left\{ \frac{\varepsilon}{8\pi}(X^2+Y^2+Z^2) + \frac{\mu}{8\pi}(L^2+M^2+N^2) \right\} d\tau \\ &= \frac{1}{4\pi A}\int \begin{vmatrix} \cos(n,x) & \cos(n,y) & \cos(n,z) \\ X & Y & Z \\ L & M & N \end{vmatrix} d\omega \end{aligned}\right\} \quad (4)$$

This equation shows that the variation of the electro-magnetic energy contained in a given volume can be expressed in terms of quantities which only depend on the surface of the volume considered.

We may replace the quantities ε and μ by unity if we are considering the ether alone, and even for non-conductors the equations can be simplified by substituting for X, Y, Z the quantities $X/\sqrt{\varepsilon}$, $Y/\sqrt{\varepsilon}$, $Z/\sqrt{\varepsilon}$, and for L, M, N, the quantities $L/\sqrt{\mu}$, $M/\sqrt{\mu}$, $N/\sqrt{\mu}$, if at the same time we substitute $A\sqrt{\varepsilon\,\mu}$ for A. The preceding reasoning has to be re-examined if we cannot suppose the body in question to be homogeneous; but investigation shows that, although for crystalline media the formulæ become much more complicated, the results arrived at are of the same general character.

Distribution of Electric Force in Good Conductors.—In those bodies which have been hitherto considered, every variation of electric force appears to be determined by the existence of magnetic force. If within a given space the magnetic force is zero, all cause capable of producing such disturbances disappears, and until magnetic perturbations penetrate within the region the electric forces remain constant. But this is not true of all bodies, for in a great number of substances electric forces when left to themselves diminish with more or less rapidity, and, in such cases, magnetic force is absolutely necessary to preserve the electric forces from variation. We shall call such substances good conductors. The most simple hypotheses we can make with regard to them are, that the diminution of electric force occurring in unit time is proportional to the strength of the force, and that the magnetic force tends to produce a variation independent of this loss, and equal to that taking place in connection with the bodies previously studied.

By the introduction of a new constant λ we can express the first hypothesis with regard to the component X of the electric force by the equation

$$A\,\varepsilon\frac{dX}{dt} = -4\pi\lambda A X$$

The second hypothesis completes the first, and leads to the statement that a magnetic force exists whose variation takes place in accordance with the equation

$$A\,\varepsilon\frac{dX}{dt} = \frac{dM}{dz} - \frac{dN}{dy} - 4\pi\lambda A X$$

The constant λ may be called the specific electric conductivity of the body. Its dimensions are those of the inverse of a velocity. It follows that the quantity $\frac{\varepsilon}{4\pi\lambda}$ is a time, that during which the electric forces when left to themselves diminish to a fraction $\frac{1}{e}$ of their former values, where e is the base of Napierian logarithms. We are thus led to the following equations, which are in perfect accordance with experiments:

$$\left.\begin{aligned} A\,\varepsilon\frac{dX}{dt} &= \frac{dM}{dz} - \frac{dN}{dy} - 4\pi\lambda A X \\ A\,\varepsilon\frac{dY}{dt} &= \frac{dN}{dx} - \frac{dL}{dz} - 4\pi\lambda A Y \\ A\,\varepsilon\frac{dZ}{dt} &= \frac{dL}{dy} - \frac{dM}{dx} - 4\pi\lambda A Z \end{aligned}\right\} \quad (5)$$

These equations replace equations (2) which only hold true for non-conducting bodies. Equations (1), however, are true for both conductors and non-conductors.

If the body, instead of being homogeneous, is heterogeneous, a further modification must be made. If the properties of a body vary from point to point it is not true that electric forces allowed to subside naturally diminish till they ultimately vanish. The final value is constant, but not zero. It is independent of time, and is found greatest where the variation of chemical properties per unit length is most rapid. We shall modify our equations by supposing that the diminution occurring in electric forces abandoned to themselves is proportional, not to the absolute values of such forces, but to the excess of the absolute values over the final ones. Thus, if X', Y' and Z' be the final values of X, Y and Z respectively, equations (5) become

$$\left.\begin{aligned} A\,\varepsilon\frac{dX}{dt} &= \frac{dM}{dz} - \frac{dN}{dy} - 4\pi\lambda A (X - X') \\ A\,\varepsilon\frac{dY}{dt} &= \frac{dN}{dx} - \frac{dL}{dz} - 4\pi\lambda A (Y - Y') \\ A\,\varepsilon\frac{dZ}{dt} &= \frac{dL}{dy} - \frac{dM}{dx} - 4\pi\lambda A (Z - Z') \end{aligned}\right\} \quad (6)$$

For crystalline conductors, the properties of which vary with direction, it cannot be assumed that when the electric forces are abandoned to subside naturally the rate of diminution of each component of electric force is proportional to the value of that component. We must assume it to be a linear function of the three components. Thus equation (1) must be modified so that each left-hand member is replaced by a linear function of $\frac{dL}{dt}$, $\frac{dM}{dt}$, and $\frac{dN}{dt}$. A similar modification occurs with the left-hand member of equation (6), and also with the last term on the right-hand side.

Boundary Conditions.—It easy to see that equations (1) and (6) (modified when necessary for crystalline conductors) may be made to represent all possible cases by a suitable choice of coefficients. If now we consider these coefficients as functions of the co-ordinates we may regard the surface of separation of two heterogeneous bodies as a space in which, although the coefficients vary with extreme rapidity, the equations are nevertheless fully applicable and should enable us to obtain the boundary conditions. In order to arrive at them in the simplest manner possible, let us suppose that the plane of $x\,y$ coincides with the surface of one of the elements.

If there is no electromotive force between the bodies in contact we see, from consideration of (1) and (6), that the values of $\frac{dX}{dz}$, $\frac{dY}{dz}$, $\frac{dM}{dz}$, $\frac{dN}{dz}$ remain finite from one side of the boundary to the other. If we indicate by suffixes $_1$ and $_2$ the side of the boundary to which a quantity refers, we have

$$Y_2 - Y_1 = 0 \qquad M_2 - M_1 = 0$$
$$X_2 - X_1 = 0 \qquad N_2 - N_1 = 0$$

Thus the tangential component of the force at the surface of separation remains constant.

We also deduce from the last equation of (1) and of (6) that the quantities

$$\mu\frac{dN}{dt} \text{ and } \varepsilon\frac{dZ}{dt} + 4\pi\lambda Z$$

have the same values on each side of the surface. The reciprocal dependence of the normal components of the force on each side of the surface takes the form

$$\mu_1\frac{dN_1}{dt} = \mu_2\frac{dN_2}{dt}$$

$$\varepsilon_1\frac{dZ_1}{dt} - \varepsilon_2\frac{dZ_2}{dt} = -4\pi(\lambda_1 Z_1 - \lambda_2 Z_2).$$

If there is an electromotive force across the bounding surface, we may assume that the component Z' of the force normal to the surface is infinitely great in the bounding layer, but of such value that the integral $\int Z'\,dz$ across the layer preserves a finite value, whose amount we may determine without knowing anything about the way in which Z' changes. We shall satisfy these suppositions by making the hypothesis that the quantity $Z - Z'$ remains finite throughout the bounding layer, as also the quantities L, M, N, X and Y. The quantity Z is thus infinite, but we can still suppose that $\frac{dZ}{dt}$ remains finite. Thus from the last equation of (6) we obtain

$$\int Z\,dz = \int Z'\,dz = \varphi,$$

and if we integrate with regard to Z the first two equations of (1) and of (6) across the bounding layer, we obtain the following conditions since, owing to the infinite thinness of the layer, the integral of each finite quantity vanishes:

$$Y_2 - Y_1 = \frac{d\varphi}{dy},$$

$$X_2 - X_1 = \frac{d\varphi}{dx},$$

$$M_2 - M_1 = 0, \qquad L_2 - L_1 = 0.$$

These equations, in conjunction with the third equations of (1) and (6), show that the quantities

$$A\,\mu\frac{dN}{dt},$$

$$A\,\varepsilon\frac{dZ}{dt} + 4\pi\lambda A (Z - Z'),$$

have the same value on both sides of the separating surface; so that by comparison with the expressions obtained when no electromotive force was acting, we see that if the material on both sides of the bounding surface is homogeneous the existence of the electromotive force has no influence on the conditions which connect the forces acting on the two sides. If the material is crystalline the

*Continued from THE ELECTRICAL WORLD, Sept. 20, 1890.

same line of reasoning can be pursued, and leads to expressions identical with the above, except that for N we must substitute a linear function of L, M and N, and for Z a similar function of X, Y and Z.

As the boundary conditions, after all, only consist of particular aspects of equations (1) and (6), we need not in future complicate matters by troubling about the modifications in our expressions necessary to represent what happens at the surface separating different media. If we sometimes neglect to give the proof that these modifications are quite determinate, it will not be because we judge such proof superfluous, but because the above example will serve as a model for obtaining it.

In what we have hitherto studied, each section has added to the number of facts embraced by the theory, and in this respect the following sections will exhibit a contrast; for they will not add to the fundamental facts, and their value will consist partly in a simpler manner of expression, and partly in the union which they will establish between our theory and old views on electrical science.

On Anti-Effective Copper in Parallel Conductors or in Coiled Conductors for Alternate Currents.*

BY SIR WILLIAM THOMSON, F. R. S.

1. It is known that by making the conductors of a circuit too thick we do not get the advantage of the whole conductivity of the metal—copper, let us say—for alternate currents. When the conductor is too thick, we have in part of it comparatively ineffective copper present; but, so far as I know, it has generally been supposed that the thicker the conductor the greater will be its whole effective conductance, and that thickening it too much can never do worse than add comparatively ineffective copper to that which is most effective in conveying the current. It might, however, be expected that we could get a positive augumentation of the effective ohmic resistance, because we know that the presence of copper in the neighborhood of a circuit carrying alternate currents causes a virtual increase of the apparent ohmic resistance of the circuit in virtue of the heat generated by the currents induced in it. May it not be that anti-effective influence such as is thus produced by copper not forming part of the circuit can be produced by copper actually in the circuit, if the conductor be too thick? Examining the question mathematically, I find that it must be answered in the affirmative, and that great augumentation of the effective ohmic resistance is actually produced if the conductor be too thick; especially in coils consisting of several layers of wire laid over one another in series around a cylindric or flat core, as in various forms of transformers.

2. Fig. 1 may be imagined to represent the secondary coil of a transformer consisting of a solid square copper wire in three layers. For simplicity we suppose the axial length to be infinitely great and straight; but the uniformity which this involves and a close practical application to its simplicity is realized in that excellent form of transformer which consists of a toroidal iron core completely covered by primary and secondary wires laid on toroidal surfaces. To simplify the mathematical work, I suppose the whole thickness of the three layers to be small in comparison with the greatest radius of curvature of the circular or flat cylindric surface on which the wire is wound, but if it is not so the solution is easily obtained, for the case of circular cylinders, in terms of the Fourier-Bessel functions. It is of no consequence for our present question what there be inside of coil No. 3, and, if we please, we may imagine there to be nothing but air; the drawing, however, indicates an iron core and space which might be occupied by the primary coil, if a transformer is the subject; or our coil $A\ A\ A\ A$ may be the primary coil of a transformer with secondary coil and core inside it, and the alternate current maintained in it by an external electromotive agent acting in an arc between its ends outside. Our present results are applicable to all these varieties of cases indifferently, all that is essential being that the total quantity of current be given at each instant, and be uniform throughout the whole length of the coiled conductor.

3. This last condition is secured by perfectness of insulation between all contiguous turns of the coil, unless we were considering so enormously long a coil that the quantity of electricity required for the essential changes of static electrification would be sensible as constituting drafts from, or contributions to, the current in the coil. The consideration of static electrification, involved in the maintenance of alternate currents through a coil such as that represented in Fig. 1, is exceedingly curious and interesting; but we do not enter on it at present at all, as in all practical cases the quantities concerned are quite infinitesimal in comparison with the whole quantity flowing n one direction or the other in the half period.

4. In the drawing, the section of the wires is represented as square; but this is not essential, and in practice a flat rectangular ribbon would, no doubt, for some dimensions of coils, be preferable. I assume the thickness of the insulation between the successive squares or rectangles in each layer to be infinitely small in comparison with the breadth of the rectangle; but the thickness of the insulation between successive layers, which is a matter of indifference to my calculations, may be anything; and would, in practice, naturally be, as shown in the diagram, considerably greater than the thickness of the insulation between the contiguous portions of the coil in each layer.

* Paper read before the British Association in Section A, Leeds, tember, 1890.

5. The full mathematical work which I hope to communicate to the *Philosophical Magazine* for publication in an early number includes an investigation of the self-induction of the coil with or without anything in its interior (such as core or primary wire of a transformer); but at present I merely give results, so far as effective ohmic resistance, or generation of heat in the interior of the wire of the coil $A\ A\ A\ A$ itself, is concerned, which, as said above, is independent of everything in the interior, and of

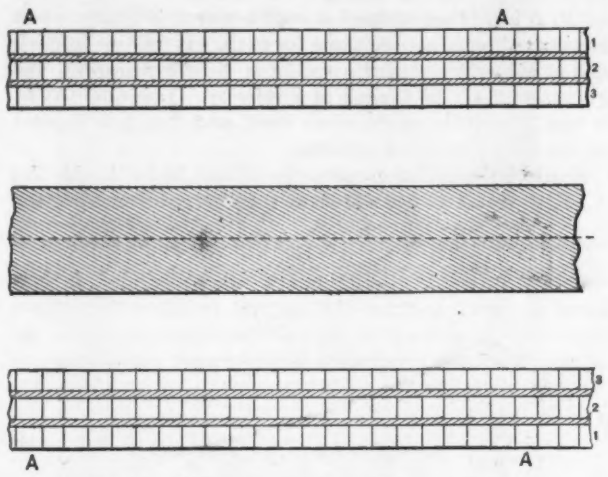


Fig. 1.—Ideal Section of Transformer.

the mode in which the alternating current is produced, provided only that the total amount of electricity crossing the section of the wire per unit of time be given at each instant.

6. As a preliminary to facilitate the expression of these results, it is convenient first to give a general statement of the solution of the problem of laminar diffusion of a simple harmonic variation, applied to the case of electric currents in a homogeneous conductor. Let the periodically varying magnetic force in the air or other insulating material in the neighborhood of so small a portion S of the surface of a conductor that we may regard it as plane be given. Resolve this magnetic force into two components, one, perpendicular to S, which we may neglect, as it has no influence in connection with the currents we are to consider; the other, parallel to S, which we shall call the effective component and denote by Y. Through any point O, of S, draw three rectangular lines $O\,X$, $O\,Y$, $O\,Z$, of which $O\,Y$ and $O\,Z$ are in S, and $O\,X$ is parallel to the direction of the effective magnetic force component Y. Let now the value of Y at time t be

$$Y = M \cos \frac{2\pi t}{T},$$

where M denotes a constant, and T the period of the alternation. The varying magnetic force Z, to whatever cause it may be due, gives rise to currents parallel to $O\,Z$ in the

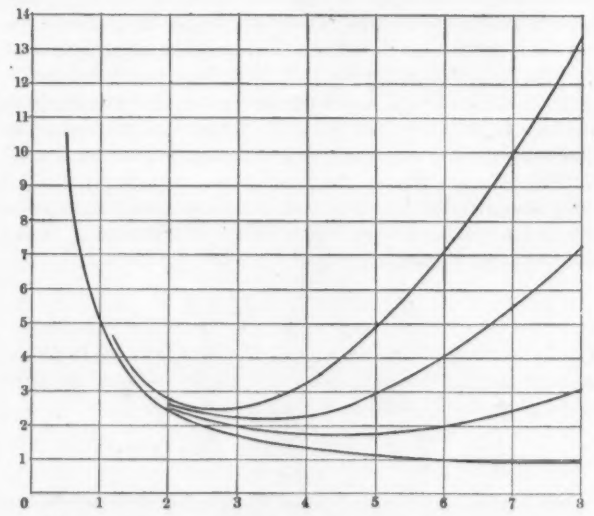


Fig. 2.—Constants for Alternating Circuits.

conductor, expressed by the following formula for γ, the current intensity at distance X from the plane S, provided T be small enough to fulfill the condition stated below:

$$\gamma = \frac{M}{\lambda \sqrt{2}} \varepsilon^{-\frac{2\pi x}{\lambda}} \cos\left(\frac{2\pi t}{T} - \frac{2\pi x}{\lambda} + \frac{1}{4}\pi\right);$$

where λ denotes what we may call the wave length of the disturbance, and is given in terms of T, the period of the disturbance, and ρ and Π the resistivity and magnetic permeability of the substance, by the following formula:

$$\lambda = \sqrt{\frac{T\rho}{\Pi}}.$$

For copper we have $\Pi = 1$, and $\rho = 1611$ square centimetres per second; and thus for 80 periods per second $\lambda = 4.49$, or, say, $4\frac{1}{2}$ centimetres. In order that the formula for γ may be approximately true, it is necessary, in the first place, that λ must be small in comparison with the distance we must travel in any direction in the surface of S before finding any deviation of it from the tangent plane through O comparable with λ. Secondly, for a very good approximation, λ may be so small that we may be able to travel inwards in any direction from O, through a space equal to at least twice λ, without coming to any other part of the bounding surface of the conductor. If, for example, the surface be a flat plate, this condition requires that the thickness be more than twice λ. But (because $\varepsilon^{-\pi}$ is less than $\frac{1}{23}$) the formula gives a very fair approximation requiring for a half the thickness of the plate inwards from S no greater correction than about 4 per cent., even if the thickness of our plate be no greater than λ. When the thickness of the plate is less than 2λ, we may consider waves of electric current as traveling inwards from its two sides, and being both sensible at the middle of the plate; and a complete solution of the problem is readily found by the method of images. But a direct analytical investigation, by which the proper conditions of relation to varying magnetic force on the two sides of the plate are fulfilled is the most convenient way of fully solving the problem, and it is thus that the results given below have been obtained.

7. The smallness of the insulating space between the successive turns in each layer of our coil $A\ A\ A\ A$, and the equality of the whole current through them all, prevent any surface disturbance from being produced at the contiguous faces, and allow the problem to be treated as if, instead of a row of squares or rectangles, we had a continuous plate forming each stratum. The smallness of the thickness of this plate in comparison with the radius of the cylindric surface to which it is bent, allows, as said above, the mathematical treatment for an infinite plate bounded by two parallel planes to be used without practical error. I have thus found an expression for the intensity of the current at any point in the metal of any one of the layers of a coil of one, two, three or more layers; and have deduced from it an expression for the quantity of heat generated per unit of time, at any instant, per unit breadth in any one of the layers. I need not at present quote the former expression; the latter is as follows: With q to denote the dynamical value of the time-average of the heat generated per unit of time at different instants of the period, per unit breadth and unit length in layer No. i, from the outside of the coil, c^2 the time-average of the square of the total current per unit breadth, and a the thickness of the layer,

$$q = \frac{2\pi\zeta}{\lambda}\,\Theta\,c^2$$

where

$$\Theta = \frac{\varepsilon^{2\theta} + 2\sin 2\theta - \varepsilon^{-2\theta}}{\varepsilon^{2\theta} - 2\cos 2\theta + \varepsilon^{-2\theta}} + 2i(i-1)\,\frac{\varepsilon^{\theta} - 2\sin\theta - \varepsilon^{-\theta}}{\varepsilon^{\theta} + 2\cos\theta + \varepsilon^{-\theta}},$$

and $\theta = \frac{2\pi a}{\lambda}$.

8. The numerical results shown in the table have been calculated, and the accompanying graphic representation (Fig. 2) drawn for me, by Mr. Magnus Maclean.

Table of Values of Θ.

$\frac{16\theta}{\pi}$	$i=1$	$i=2$	$i=3$	$i=4$
1	5.113	5.118	5.127	5.141
2	2.553	2.592	2.669	2.786
4	1.316	1.634	2.270	3.224
6	.9854	1.997	4.019	7.053
8	.9173	2.993	7.143	13.37
10	.9452	4.062	10.30	19.65
12	.9822	4.899	12.73	24.48
14	1.000	5.276	13.83	26.66
16	1.002	5.362	14.08	27.16
∞		5.000	13.00	25.00

9. We see from the table and curves that each curve has a minimum distance from the line of abscissas, and that each comes to a horizontal asymptote, parallel to the line of abscissas, for $\theta = \infty$. By looking at the formula we see that there is, in fact, an infinite succession of minimums and maximums in the expression for Θ; but it is only the first minimum and following maximum that occur within the range of variation of Θ, which we regard as sensible. In the case of $i = 1$ the formula gives $\theta = \frac{1}{4}\pi$ for the first minimum. The curves show for the cases of $i = 2, 3, 4$, respectively, the first minimum at $\frac{16\theta}{\pi} = 4\frac{1}{4}$, 3 and 2.6, respectively. The thickness which corresponds to $\theta = \pi$ is the half wave length of the electric disturbance, which, as we have seen, is for copper 2.244 centimetres when the frequency of the alternations is 80 periods per second; and for this case, therefore, the thicknesses that give minimum generation of heat in the first, second, third and fourth layers are respectively 11.22, 6.31, 4.21 and 3.65 millimetres. Anything more of continuous copper than these thicknesses in any of the layers would be not merely ineffective or comparatively ineffective, but would be positively anti-effective. Even with so small a thickness as 2 8 millimetres for copper and frequency 80, line 2 of the table (corresponding to a sixteenth of the wave length) shows, in the first, second, third and fourth layers, losses of 0.3 per cent., 2 per cent., 5 per cent., and 10 per cent. in excess of that due to the true ohmic resistance of the copper were it all effective. When the size chosen for the transformer and the amount of output required of it are

such that a thickness of 2½ millimetres in the direction perpendicular to the lavers is insufficient, a remedy is to be had by using braided wire, or twisted strand, with slight insulation of varnish or whitewash, crushed or rolled into rectangular or square form of the desired thickness and breadth. A very slight resistance between the different wires thus crushed together would suffice to cause the current to run nearly enough full bore to do away with any sensible loss from the cause which forms the subject of this communication.

Testing Iron.*

BY J. SWINBURNE AND W. F. BOURNE.

In practical work iron has to be tested as to its permeability and as to the loss by hysteresis. As regards permeability tests, the ordinary ballistic galvanometer method can, of course, be used; but a ballistic galvanometer is not a convenient instrument, and the method is too slow for practical use. It may, therefore, be of interest to describe the apparatus we use commercially. It is the development of a method devised in 1886. (See *Phil. Mag.*, July, 1887.)

The various samples of iron are obtained in the form of wire, and made up into rings, being wound on a former kept for the purpose, so that all the rings are alike as to dimensions. Before winding, the specific gravity of the iron is taken by weighing, and the specific resistance is measured. The ring is weighed to get the volume of iron, and is then wound with suitable primary and secondary wires.

The arrangement is shown diagrammatically in the annexed figure:

The circuit from secondary cells is led through an adjustable resistance, then through an ammeter to a commutator, resembling Brillouin's, which is driven by a belt from any shafting that may be near. The circuit is led through the primary to an induction box to the ring under test, and then back to the commutator. The circuit is then led back to the cells. The induction box consists of a primary coil, standing on end, and a number of secondary coils arranged so that the mutual induction is the same for all of them. The secondary coils are led to buttons, and the switches include them by ones or tens, making the readings in steps of one per cent. of the highest. The primary of the sample ring is in series with that of the induction box. The secondaries are coupled so as to oppose each other, and arranged in circuit with a second commutator, a Varley, or, as it is more often called, a Deprez d'Arsonval galvanometer, being inserted in

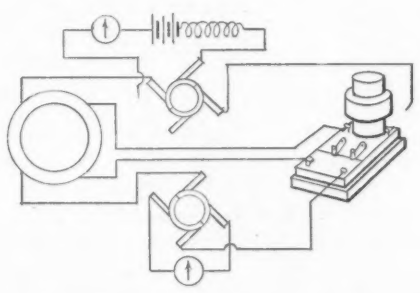


FIG. 1.—APPARATUS FOR MAGNETIC CONSTANTS.

the circuit. The two commutators are, of course, on the same spindle. The adjustment of the induction box was carried out as follows: The coils were roughly calculated to give a mutual induction a little in excess of a convenient round number per turn of secondary. A cylinder of a known diameter with a known number of turns per centimetre in the primary and a round number of turns in the pilot coil was taken and put in the place of the sample ring, and its mutual induction measured with the induction box. To allow for the error due to the shortness of the cylinder of the standard coil, it was slipped out of the pilot coil, and moved exactly half its length in a direction along its axis, and a new reading taken. This reading gave the error due to the ends of the cylinder. A shunt was then put across the primary induction box, so as to make the readings come out in microhenrys.

To test a sample of iron all that is necessary is to alter the mutual induction by steps, and to bring the galvanometer to zero for each step by means of the adjustable resistance. As the galvanometer is dead beat, the readings can be taken in a few minutes.

The importance of loss by hysteresis in alternate-current work is only now beginning to be fully realized. There are several ways of measuring the loss in transformers, but none of them seem satisfactory. Sometimes the transformer is put in a calorimeter, or else it is assumed that the pressure and even the exciting current vary harmonically, and have a so-called "angle of lag." The published efficiencies of most transformers are got by finding the loss from the copper resistances, and neglecting the loss in iron altogether. There is still another method, and that is taking the curves of pressure and current. Professor Ryan has been singularly successful in this, with a modification of Joubert's method.

Tests of transformers by means of lag angles and calorimeters have been published by Profs. Ferraris and Ayrton, and Major Cardew. As the loss in a transformer can be divided into the loss in the copper, which varies as the square of the load, and the loss in the iron by hysteresis and Foucault currents which remains constant, these results can be checked. The results published, as obtained by these experimenters, show inaccuracies that make them quite valueless. The loss in the iron in Prof. Ayrton's experiments varies 160 per cent of its smallest value, while Prof. Ferraris' cores give out power working as refrigerators. (See article "On Induction and Other Things," *Electrical Review*, October, 1887.)

There is really little reason for measuring the loss in a transformer; it is much simpler to measure the loss in the iron. No one would think of measuring the loss in the copper by means of a calorimeter or angle of lag method. All that is needed is to measure the effective current and multiply its square by the resistance, the resistance being determined from the specific resistance of copper, or by direct measurement. Similarly, in the case of the iron, it is best to determine the qualities of the iron once for all, and then the efficiencies of all transformers made of it can be foretold.

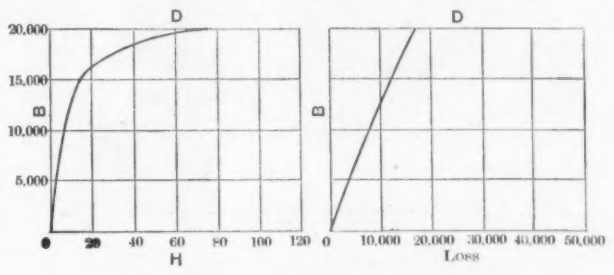


FIG. 2.—MAGNETIC CONSTANTS OF IRON.

We use the same rings as for the permeability test, but do not employ the secondary wires. The loss of power at various frequencies and inductions is taken with a wattmeter. It is sometimes supposed that a wattmeter cannot be made with little enough self-induction to read accurately. If there is much self-induction in the pressure or shunt circuit, the reading will be lower than that with a direct current if there is no self-induction in the circuit in which the waste of power is to be measured; but if the current is behind the pressure, as in measuring the loss in iron, the wattmeter may even read too high. We therefore designed a special instrument, which was made for us by pupils of the London College of Electrical Engineers. The current coils are fixed, and the moving coil is suspended by a fine wire, with a fine spring at the foot, to take the electricity out again. The moving coil has few turns and little self-induction, and a large non-inductively wound resistance is in series with it. This wattmeter can be read with a mirror, if desired; but with 2,900 ohms in series with the pressure coil it gives a torsion of two degrees per watt on a non-inductive resistance. The series resistance is not wound with a looped wire as is usual in resistance boxes, because this method is not good, the insulation being apt to break down. A single wire was therefore used. When one layer was wound, the bobbin was reversed in the lathe, and the next layer wound in the opposite direction, a thin layer of insulation being put between the layers. This method secures absence of self-induction and good insulation, as the beginning and end of the coil are kept well apart. The readings are taken by bringing the index back to zero by turning the suspension, so that the mutual induction of the coils is zero, as the coils are at right angles.

The self-induction of the pressure coil was not directly measured, as that would give us no useful information, as we do not know the variation of the current and pressure of air dynamos. They certainly do not vary harmonically, and at full load the pressure rises slowly and falls suddenly in each half period.

The wattmeter was therefore subjected to a severe test. Readings were first taken with direct currents on a resistance; readings were then taken on the same resistance with an alternate current. This resistance had very little self-induction, so that any self-induction in the pressure coil should lessen the reading, by making the current in the pressure coil lag, and also by reducing it. The reading with the alternate current was 2.1 per cent. less than with the direct. This figure is entered in the note-books, but though it is too small to matter in our work, it is larger than it ought to be. The next test was to measure the power taken by a coil with the same current and same pressure, but with no resistance and large self-induction. It is difficult to make up a coil with no iron core to take 50 volts and 10 ampères with no appreciable loss by resistance; we therefore took a hedgehog transformer, and measured the power taken by it. The reading was taken with 50 volts and 4.2 ampères. If the pressure coil had any appreciable self-induction, the reading would be considerable; it might, in fact, be anything up to about 200 watts. The least self-induction would increase the reading enormously. The reading was 11 watts, and the calculated loss by copper and iron in the transformer with only 50 volts on its secondary was 10.3; so the wattmeter is practically correct. Let it be supposed, however, that the loss in iron was really less than this, and that the loss was two watts less than the reading. This is an extreme assumption; but we may see how much such an error would affect our readings of the sample rings. The assumed error is one per cent. of the product of the pressure and current. Now, in the case of a closed iron circuit the power is about half the product; so this would lead to an error of 2 per cent. in the loss in the iron. In a closed-circuit transformer the loss in iron is, roughly speaking, 10 per cent. at full load, and about 40 per cent., to take a low figure, taken over the day; so that the error would be 0.2 per cent. and one per cent. In the hedgehog form the loss in iron is about 1.5 per cent. at full, and 15 per cent. at all day loads; so the errors are .03 and 0.3 per cent., respectively, which are too small to matter. As a matter of fact, they are much less than the various errors of observation that creep into such work. Measuring the power in an open circuit transformer is also a most difficult case, for the least self-induction then gives rise to the largest error; in measuring the power in a closed circuit ring the errors are less.

We give a number of curves of permeability and of $f\ E\ d\ Q$ per cubic centimetre for different samples of iron. These are practically the same as curves of $f\ I\ d\ H$; but $f\ E\ d\ Q$ seems a better way of writing it, as $f\ I\ d\ H$ can scarcely be said to have any physical meaning, and has even had the effect of not suggesting that the reversal involves waste of energy; indeed, it seems to have rather disguised the fact.

In completing these curves some corrections have been made. The wattmeter absorbs some power itself, as the pressure coil circuit is led through the current coils. We might have compensated for this in one of the ways described to Section A by one of us in 1887, but in this case did not think it worth while. The Foucault current losses are also corrected. The losses in the wires themselves can be calculated with rigid accuracy, as explained in a paper on "Transformer Design," which one of us had the honor of reading before Section G last year. There might also be some loss by Foucault currents, due to imperfect insulation between the wires of the core. The insulation is, however, too good to allow this; in fact, the resistance between two wires, about an inch apart, runs into ohms, the measurement being seven ohms in the particular example taken. The losses by Foucault currents are frequently over-estimated by writers on the subject. If the specific resistance of the iron is known, they can nearly always be calculated with much greater accuracy than they can be measured. The loss by the copper resistance is also allowed for the curves. Though it is generally the practice to give all the steps in a paper like this, we think it better to give the results only; for,

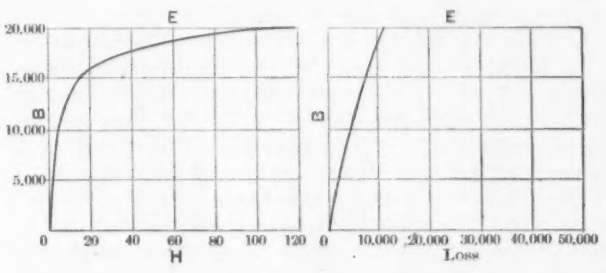


FIG. 3.—MAGNETIC CONSTANTS OF IRON.

though the paper then looks less imposing than if full of curves and calculations, it is more likely to be useful.

We have not yet tested the same sample at very different frequencies to see if there is any time lag. From the comparatively small loss at high frequencies it is not probable there is any appreciable time lag.

On Alternate Currents in Parallel Conductors of Homogeneous or Heterogeneous Substances.†

BY SIR WILLIAM THOMSON, F. R. S.

This paper consists of a description of some of the results of a full mathematical investigation of the subject, which I hope to communicate to the *Philosophical Magazine* for an early number:

1. Two or more straight parallel conductors, supposed for simplicity to be infinitely long, have alternating currents maintained in them by an alternate-current dynamo or other electromotive agent applied to one set of their ends at so great a distance from the portion investigated that in it the currents are not sensibly deviated from parallel straight lines. The other sets of ends may, indifferently in respect to our present problem, be either all connected together without resistance, or through resistances, or through electromotive agents. All that we are concerned with at present is, that the conductors we consider form closed circuits, or one closed circuit, and that therefore the total quantities of electricity per unit of time at any instant traversing the normal sections in opposite directions are equal.

2. We suppose the period of the alternation to be very great in comparison with the time taken by light to traverse a distance equal to the greatest diameter of cross section of our whole group of conductors. This supposition is implied in the previous assumptions of parallel rectilinearity

* Paper read before the British Association in Section A, Leeds, September, 1890.

† Author's abstract of a paper read before the British Association in Section A, Leeds, September, 1890.

of the electric stream lines. and of equality of the quantities of electricity traversing in opposite directions the several areas of a normal section.

3. We further suppose that the length of our conductors and their effective ohmic resistances are so moderate* that the quantities of electricity deposited on and removed from their boundaries to supply the electro-static forces along the conductors required for producing the alternations of the currents are negligible in comparison with the total quantity flowing in either direction in the half-period. This supposition excludes important practical problems of telegraphy and telephony, the problem of long submarine cables, for instance; but it includes the problem of electric lighting by alternating currents transmitted at high tension through considerable distances; as, for example, from Deptford to London.

4. The general investigation includes as readily any number of separate circuits of parallel conductors as a single circuit, but, for simplicity in describing results, I suppose our system of conductors to be so joined at their ends as to constitute a single simple circuit of two parallel conductors.† It may be either two parallel conductors or one conductor, one of which may or may not surround the other, as shown in Figs. 1 and 2, representing cross-sections. Each conductor may be single as in Figs. 1 and 2 or either may be multiple parallels.

5. We suppose each conductor to be the homogeneous in substance, and in cross-section from end to end, but not necessarily homogeneous in different parts of the cross-section. Thus the two conductors, or the different parts of either, may be of different metals, or either conductor or any part of either conductor may consist of two metals (as iron and copper, or iron and lead) laid parallel and soldered together.

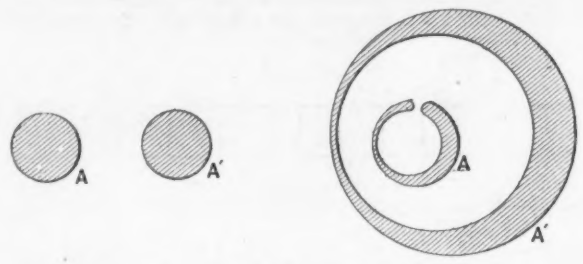
6. We shall call A and A' the cross-sectional areas or groups of areas of the two conductors respectively of the other. All the different portions of A are connected metallically at their two ends, and are thus all of them at one potential at one end and another potential at the other end; and similarly for A'. The homogeneousness of the material and of the cross-sections along the length of the conductors and the uniformity of the total currents assumed in section 3, implies that all the different parts of A in one cross-sectional plane are at one potential, even though A consist of mutually isolated parts, or A' consist of isolated parts. If, as in Figs. 1 and 2, all the parts of A are in mutual metallic connection, and all the parts of A' are in mutual metallic connection, this would entail uniformity of potential through A, and uniformity of potential through A', even without the limitation of our subject laid down in section 3.

7. The following are some of the most noteworthy results of the full mathematical treatment of the subject.

I. When the period of alternation is large in comparison with 400 times the square of the greatest thickness or diameter of any of the conductors, multiplied by its magnetic permeability, and divided by its electric resistivity, the current intensity is distributed through each conductor inversely as the electric resistivity; the phase of alternation of the current is the same as the phase of the electromotive force: and the current across every infinitesimal area of the cross-section is calculated, according to the electromotive force at each instant, by simple application of Ohm's law.

II. When the period is very small in comparison with 400 times the square of the smallest thickness, or diameter of any of the conductors, multiplied by its magnetic permeability and divided by its electric resistivity, the current is confined to an exceedingly thin surface-stratum of the conductors. The thickness of this stratum is directly as the square root of the quotient of resistivity, divided by magnetic permeability, of the substance in different parts of the surface. The total quantity of the current per unit breadth of the surface is independent of the material, and, except in such cases as those referred to at the end of II. below, varies in each cross-section in simple proportion to the electric surface density of the static electrification induced by the electromotive force applied between the extremities for maintaining the current. The distribution of this electric density is similar in all cross-sections, but its absolute magnitude at corresponding points of the cross-section varies along the length of the conductor in simple proportion to the difference of electric potential between A and A', and is zero at one end, in the particular case in which the conductors are connected through zero resistance at one end, while the electromotive force is applied by an alternate current dynamo at the other end. On the other hand, the surface distribution of electric current is uniform throughout the whole length of the conductors, and it is only its distribution in different parts of the cross-section that varies as the electric density.

The proportionality of surface intensity of the current to electric density, asserted above, fails clearly in any case in which the circumstances are such that the distance we must travel along the surface to find a sensible difference in electric density is not very great in comparison with the thickness of the current-stratum. Such a case is represented in Fig. 3, which is drawn to scale for alternate currents of period $\frac{1}{80}$th of a second in round rods of copper of six centimetres diameter. The spaces between the outer circular boundaries and the inner fine circles indicate what I have called the mhoic thickness,‡ being .714 of a centi-



Figs. 1 and 2.—Cross Sections of Conductors.

metre for copper of resistivity 1,611 square centimetres per second. The full solution for such a case as that represented in Fig. 3 belongs to the large class of cases intermediate between I. and II., and could only be arrived at by a kind of transcendent mathematics not hitherto worked. But without working it out, it is easy to see how the time-maximum intensity of the current will diminish inwards from the surface, and will be, at any point of either of the inner fine circles, about one-half or one-third of what it is at the nearest point of the boundary surface; and that at points in the surface distant from $B\,B'$ by one-half or one or two times the mhoic thickness the current intensity will be much smaller than it is at $B\,B'$.

III. In Case I. the heat generated per unit of time, per unit of volume, in different parts of the conductors, is inversely as the electric resistivity of the substance, and directly as the square of the total strength of current, at any instant. In Case II. the time-average of the heat generated per unit of time, per unit of area of the current stratum, is as the time-average of the square of the quantity of current per unit breadth, multiplied by the square root of the product of the electric resistivity into the magnetic permeability.

IV. Example of III.: Let the conductor A be a thin flat bar, as may be shown by a diagram, A' being a tube surrounding A, or another flat bar like A, or a conductor of any form whatever, provided only that its shortest distance from A is a considerable multiple of the breadth of A. The thickness of A must be sufficiently great to satisfy the condition of II., and its breadth must be a large multiple of its thickness (For copper carrying alternating currents of frequency 80 periods per second, these conditions will be practically fulfilled by a flat bar of 4 centimetres thickness and 30 or 40 centimetres breadth.) The current in it is chiefly confined to two strata extending to small distances inwards from its two sides. (For copper and frequency 80 periods per second, the time-maximum of intensity of the current at the surface will be about ε^2, or 7.4 times what it is at a distance 1.43 centimetres in from the surface.) The quantity of current per unit breadth, or, as we may call it for brevity, the

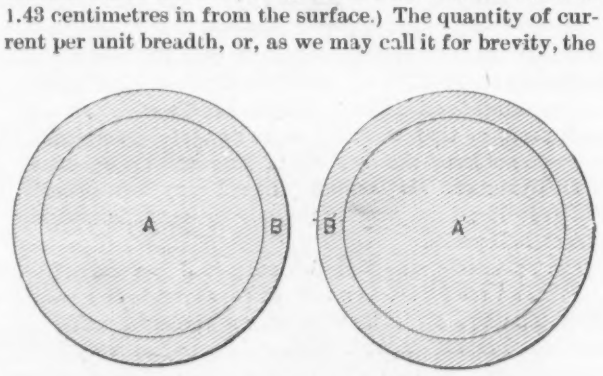


Fig. 3.—Cross Sections of Conductors.

surface-density of the current in each stratum, is determined by the well-known solution of the problem of finding the surface-electric density of an electrified ellipsoid of conductive material undisturbed by any other electrified body. The case we have to consider is that of an ellipsoid whose longest diameter is infinite, medium diameter the breadth of our flat conductor, and least diameter infinitely small. In this case the electric density varies inversely as $\surd(O\,B^2 - O\,P^2)$. The graphic construction of this would show $P\,Q = \surd(O\,B^2 - O\,P^2)$, and we conclude that the time-maximum of the surface-density of the current varies inversely as $P\,Q$. The infinity, which in the electric problem we find for electric density of the ideal conductor, is obviated for the electric current problem by the proper consideration of the rectangular corners or the rounded edge (as the case may be) of our copper bar, which, though exceedingly interesting, is not included in the present communication. Suffice it to say that there will be no infinities, even if the corners be true mathematical angles.

V. Example of Cases I. and II.: Let A consist of three circular wires, C, L and I, of copper, lead and iron respectively. In Case I. the quantities of the whole current they will carry and the quantities of heat generated per unit of time in them will be inversely as their resistivities. In Case II., if the centres of the three circular cross-sections form an equilateral triangle, the quantities of heat generated in them will be directly as the square roots of the resistivities for C and L, and for I would be as the square root of the product of the resistivity into the magnetic permeability, if the magnetic permeability were constant and the viscous or frictional resistance to change of magnetism nothing for the iron in the actual circumstances. This last supposition is probably true approximately with a permeability of $\frac{1}{80}$ for iron steel, according to Lord Rayleigh, if the current is so small that the greatest magnetizing force acting on the iron is less than .1 C.-G.-S.

VI. The dependence of the total quantity carried on extent of surface, according to the electrostatic problem described in II., justifies Snow Harris, and proves that those who condemned him out of Ohm's law were wrong, in respect to his advising tubes or broad plates for lightning conductors; but does not justify him in bringing them down in the interior of a ship (even through the powder magazine) instead of across the deck and down its sides, or from the masts along the rigging and down the sides to the water. The non-dependence of the total quantities of current on the material, whether iron or non-magnetic metals, seems quite in accordance with Dr. Oliver Lodge's experiments and doctrines regarding "alternative path" and lightning conductors. The case of alternate currents is, of course, not exactly that of lightning discharges; but from it, by Fourier's methods, we infer the main conclusions of II. and V., whether the discharges be oscillatory or non-oscillatory, provided only that it be as sudden as we have reason to believe lightning discharges are.

Atmospheric Electricity.

In a paper recently read before the Vienna Academy, Herren Elster and Geitel give the results of a year and a half's observations of atmospheric electricity on the north side of Wolfenbüttel (bordering an extensive meadow). They used a stand carrying a petroleum flame, and connected by insulated wire with an electroscope. A marked difference was found in the phenomena of spring, summer and autumn, on the one hand, and winter on the other. It appears to the authors that other factors than humidity, with which Exner seeks to explain the variations, are concerned in the case. When the temperature goes below zero, cold mist being then generally present, there is often rather a sharp rise in the values, the aqueous vapor having then less action. Rainfall in a neighboring region lowers the fall of potential both in winter and summer, and a disturbance of the normal course will announce a coming change in places still unclouded. Snow, it seems, rather raises the values. It has been shown by Linss that the course of the fall of potential is inversely as the coefficient of dispersion of the air for electricity; which, again, depends not only on the dust and aqueous vapor present, but also, according to Arrhenius' theory, on a sort of electrolytic or dissociative action of the sun's rays on the atmosphere (thus it has been shown that electricity escapes from a conductor under the influence of ultra-violet rays). The authors find their results support the latter view. They consider that the electric processes during formation of precipitates are the chief cause of the disturbance of the normal condition.

The Telegraph in China.

The first telegraph in China, says one of our daily contemporaries in giving a history of telegraph building in that country, was built in 1856 during a war in Formosa. The viceroy of the province of Fuh-Keen ordered the construction of a line of telegraph from Pagoda Island to Foochow-Foo. The government disapproved of his plan and made several attempts to frustrate the undertaking, but as the ministers from foreign countries in Pekin insisted upon the fulfillment of the contract with the telegraph company, the line was finished. There was considerable opposition on the part of the Chinese people to the innovation, but this was gradually dispelled. Now, the telegraph has been gradually extended, until its use is common in a very large part of the kingdom. There is a line between Pekin and Tientsin, and also one connecting the capital with the principal places in Mantchuria and extending up to the Russian frontier on the Amoor and the Ussuri rivers. All the seven treaty ports on the Yangtse River, also all the principal cities of the empire, are now connected with each other and with the capital. The line from Canton westerly has been pushed to Yunnan-fu, the capital of the province of Yunnan, near the borders of Burmah. Lines have also been constructed between Foochow and Canton, and between Port Arthur and the capital of Corea, and the line along the Yangtse Valley has been extended far into the interior. By an arrangement recently made with the Russian authorities, the Chinese and Siberian lines in the Amoor Valley are to be joined, so that there will be direct telegraphic communication between Pekin and Europe.

* The circumstance in which this condition is fulfilled may be usefully illustrated by considering the important practical cases of submarine cables, and of metallic circuits of two parallel wires insulated at a distance nothing less than a few hundred times their diameter. For all these cases the numeric expressing the electrostatic capacity of either conductor (the other supposed for the moment to be at zero potential) is between 2 and 0.1, and for our present rough comparison may be regarded as moderate in comparison with unity. On this supposition the condition of the text requires for fulfillment that the mean proportional between the velocity which expresses in electro magnetic measure the resistance of one of the conductors and the velocity of a body traveling the length of the conductor, in a time equal to half the period of alternation, shall be exceedingly small in comparison with the velocity of light.

† The case of a single circuit made up of parallel conductors, so joined at their ends that to travel once round it we must go and come two or three or more times along separate conductors, joined by their ends in series, so as to make one circuit, is especially considered in my Paper on "Anti-Effective Copper in Parallel or in Coiled Conductors for Alternating Currents," to be communicated presently to Section A.

‡ "Collected Papers," Vol. III., Art. CII., § 35.

The Hyer-Sheehan Electric Motor.

The result aimed at in the construction of the Hyer-Sheehan motors, as in every rightly constructed electric motor, is to produce a given amount of power at as low a speed as possible, and to keep the weight as low as is consistent with obtaining a high efficiency of conversion. It is also desirable that the speed of rotation of the shaft should be kept constant notwithstanding sudden changes in the load, which may vary from zero to the full capacity of the machine. Many designers hold that in order to obtain this result it is necessary that the field should be very powerful relatively to the armature, and that the latter should be wound with the least practical number of turns of wire, and that its resistance should be extremely low. These points have been considered in the design of the motors here described, and the result is said to be a highly efficient machine.

The magnetic circuit is constructed of the softest cast iron, is extremely short and of large cross section. In this way a given amount of magnetism is produced with a

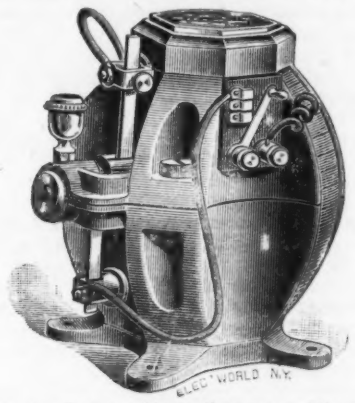


FIG. 1.—SMALL HYER-SHEEHAN MOTOR.

comparatively low expenditure of electrical energy in the field coil.

In considering the magnetic circuit in its relation to the armature, it has been found desirable to change the shape of the polar faces very materially from those at present in use in other motors, and the results are said to have been very gratifying in reducing to a minimum the inactive wire on the armature, and in decreasing the extent of the neutral portion of field so that every coil of the armature is in a working position at all positions of the armature.

The armature is of entirely new construction, being a drum of large diameter and relatively short length, this construction giving a high peripheral velocity at a low speed of shaft. It is built up of a number of discs of soft charcoal iron, which are carefully insulated from each other and from the shaft, the result being that eddy currents, which are always injurious to the efficient working of a ma hine, are very largely obviated. These discs have teeth projecting between the armature coils. The mag-

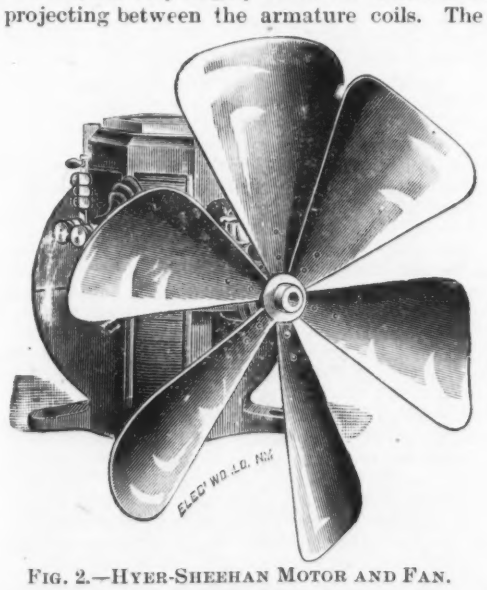


FIG. 2.—HYER-SHEEHAN MOTOR AND FAN.

netic resistance of the armature is thereby greatly reduced, and the teeth also serve to keep the armature coils in their proper position relatively to each other, thus rendering the armature strong mechanically.

The weight of the entire machine is reduced as much as it can be consistently with producing an efficient motor and one which is capable of constant running if necessary at a point above its rated capacity. The construction is exceedingly simple and of the best workmanship throughout. Nothing has been sacrificed to cheapness, although simplicity and economy, together with high efficiency, have been the points aimed at in the construction.

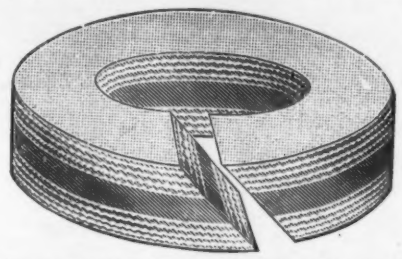
Fig. 1 shows the Hyer-Sheehan motor of small size, from which a good idea of its construction can be obtained. Fig. 2 shows one of the motors in use for ventilating purposes. The following table gives some interesting details of the motor in sizes varying from one-eighth to one horse power:

H. P	Speed.	E. M. F.	Current.	Height.	Floor space.	Weight
⅛	1,900	110	1⅜ Amp.	7 inches.	5 × 5	20 lbs.
¼	1,850	110	2½ "	9 "	6¼ × 6	38 "
½	1,750	110	4¼ "	10¼ "	10 × 8½	75 "
1	1,625	110	8½ "	12 "	11¼ × 10	125 "

These motors are wound for both constant potential and constant current circuits, and work equally well on either. They are wound with either series or shunt coils, according to the work for which they are designed. The machines are finished in either nickel or polished brass, and have a very handsome appearance.

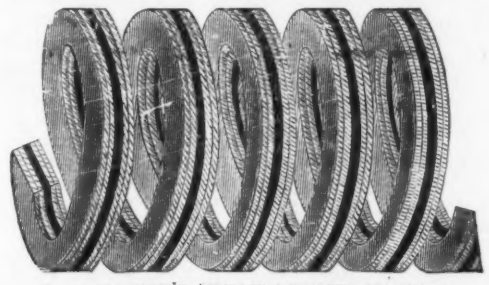
An Improved Packing for Steam Engines.

The accompanying illustrations show what is known as Chesterton's expansion packing, which is made especially for use on high-speed engines. In this style of packing the



CHESTERTON'S STEAM ENGINE PACKING.

gum is placed in the centre, the idea being that in this position it is better protected from the engine oil, and also from the oil used in the preparation of the packing. In some of the earlier styles of ring packing the gum was placed on the outside, and being thus exposed to more or less oil, its elasticity was soon lost. In the style of packing here shown, which is manufactured in the two forms shown in the figures by A. W. Chesterton & Co., of Boston, Mass., the gum being in the centre acts as a soft expansion cushion and possesses a very high degree of elasticity. It is said to be very durable and especially adapted for use on high-speed engines. It is now in use in some very large electric light and power stations, among them being the power station of the West End electric

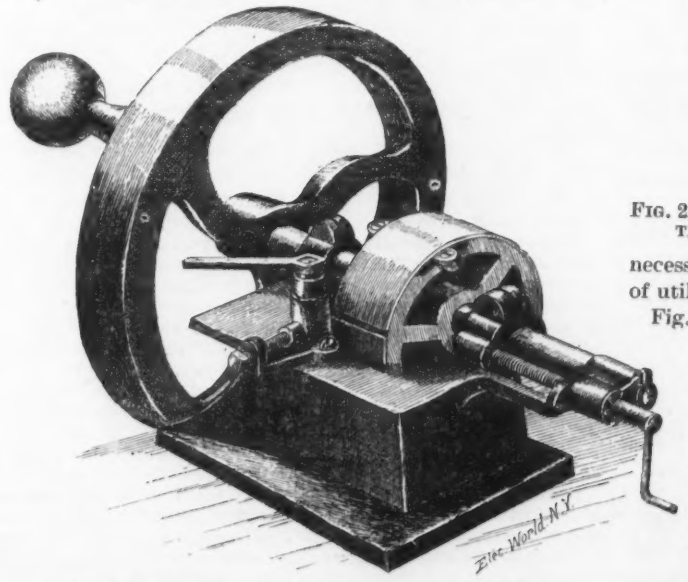


CHESTERTON'S STEAM ENGINE PACKING.

railway, in Boston, and the electric light stations in Boston, Chelsea, East Boston, Cambridge, Somerville, Lynn, Salem, and many other towns in Massachusetts.

Machine for Turning Commutators.

Managers of electric light stations have often felt the need of a cheap and simple machine for turning down the commutators of dynamos and motors that have become worn by excessive or undue sparking. The accompanying illustration shows a machine which has been devised for this purpose by Mr. H. G. McLean, of McPherson, Kan. As will be seen by the cut, the machine may be operated by hand, or by power, as desired. The shaft of the ma-



MCLEAN'S MACHINE FOR TURNING COMMUTATORS.

chine, on which the jig is fastened by a set screw, is made of thirteen-sixteenths inch cold rolled steel, and is reduced to three-eighths of an inch where it passes through the block connecting it to the feed screw, and has a collar with a single tooth projecting far enough to engage with one of the six teeth of the wheel on the feed screw. In the position shown in the cut the tool has just been started across the surface of the commutator. When the entire length of the commutator has been passed over and the single tooth has passed out of gear with the wheel on the feed screw, it is only necessary to turn the feed screw backward with the handle shown until the segments are clear of the tool, and this can be set by using the wrench shown on the tool post. The tool post is stationary, being fastened to the frame of the machine with machine screws. Each machine is furnished with two tools made of five-sixteenths of an inch round stub steel.

The frame is made in one solid casting, the bearings being drilled and finished with a Whitworth fluted reamer and afterward split through the lugs on the top with a hack-saw and a machine screw put into each to provide for necessary adjustment. The machine shown in the cut is adapted for use on the commutators of Thomson-Houston dynamos, but it is also made in styles suitable for other dynamos. One of these machines is in use in the plant of the Citizens' Electric Illuminating Company, in Brooklyn, and is giving excellent satisfaction.

A Diminutive Battery and its Applications.

We show herewith a trio of as neat little electrical devices as have appeared for some time. They comprise a very complete and convenient little outfit for domestic purposes, and are being brought to public attention by the Nassau Electrical Company, of this city. Fig. 2 shows the battery, which is the essential part of the system. The problem of making a small powerful portable battery has been a very vexatious one, but the present cell comes as

FIG. 1.—PORTABLE ELECTRIC BELL.

near its solution as could well be wished. It is a modification of the well known chloride of silver battery. The principal difficulties with this type have heretofore been the difficulty of sealing the cell and the danger of short-circuiting. These have been very successfully overcome in the present arrangement which is shown, actual size, in the cut. It consists of a zinc tube, at once electrode and case, measuring five-eighths of an inch in diameter and less than three inches long. Within this is the excitant, combined with a stiff jelly, and the other electrode. Contact is made in this form of battery by the projecting silver wire and by the case, no wiring whatever being

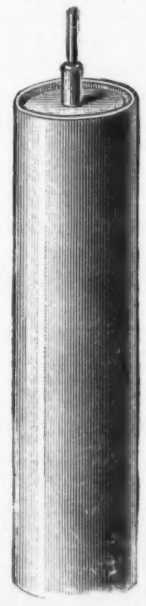


FIG. 2.—DIMINUTIVE BATTERY, FULL SIZE.

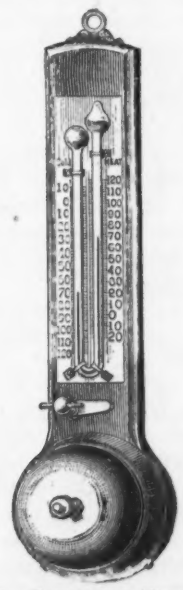


FIG. 3.—COMBINED THERMOMETER, BATTERY AND BELL.

necessary. This very compact and neat form of cell allows of utilization in several unusual fashions.

Fig. 3 shows an electric alarm thermometer, intended to give warning when the temperature in a room rises above or falls below certain fixed limits. It consists of a thermometer of the maximum and minimum class, with platinum electrodes sealed through the glass to mark the desired temperatures. On the base of the thermometer is a little electric bell, and into the base is thrust a battery, simply making connection with an abutment and the spring clip which holds it in place. There is absolutely no wiring, and the bell, which can be cut off, if desired, by a little switch, operates as soon as the predetermined temperature is reached. Another very pretty application is shown in Fig. 1, which consists of an electric bell connected by a flexible cord to the push button which contains the battery. The push button is of convenient size for handling, and a slight pressure at its end throws the bell into operation. The great convenience of these forms of apparatus lies in the fact that no wiring is necessary, and that the batteries when worn out—which takes a considerable time—can be replaced in a moment with absolute certainty of making good contacts. The little cell is quite powerful, having an electromotive force of something over a volt, and giving on short circuit a current of over two ampères. The operation of this portable apparatus is admirable, and it should find many friends among those

who do not desire to be bothered with the care of an ordinary battery and system of wiring, and desire at the same time the immense convenience of small electrical appliances. The present arrangement completely does away with any care whatever for the batteries, for when one finally gives out it can be replaced as quickly as one could fit a single wire into a binding post.

Historical Note on Electric Conduits.

BY DAVID BROOKS.

It is fully 30 years since conduits made of wood were laid between London and Liverpool and between Liverpool and Manchester, with gutta percha insulated conductors drawn into them. The insulation failed in less than one year. In Brussels and Antwerp conduits were made of brick and gutta percha insulated cables laid in them, the intervening space being filled with sand. This was done to protect the insulation from the effects of damp air and gases. These conduits were shown to me in 1873. The administration of the telegraphs was fairly well satisfied with the method of protecting the insulation.

It is 25 years since Matthew Gray, of London, obtained a patent for pulling the cables into iron tubes and filling the tubes with water. This method is practiced to this day by the English post office department. The land portion of sub-marine cables is also protected in this manner. The cables in the sewers of Paris are drawn into and protected by lead pipes, and some of these have been working for more than 30 years. All gas mains in Paris are not in the sewers, but far above them. The sewers being made of solid masonry are perfectly free from explosive gases and ammoniacal salts which are very destructive to all kinds of insulation. The London *Electrician* of Aug. 1, 1890, has an article on "Insulation Measurements of Some German Underground Cables." From this report by one of the government electricians I learn that the insulation of these cables does not, up to this date, show material decay, especially on those laid in 1876 between Berlin and Halle, which were the first. These conductors were laid at a depth of one metre and carefully packed with clay.

We see by this what methods have been employed to perserve the insulation from the agencies that have so seriously affected everything that has been drawn into the conduits of New York City and other places. Lead covered cables are protected to some extent by the use of paint, but this is soon destroyed by the illuminating gases, which act as a solvent.

Conduits are expensive. If those who use them are compelled to pay a yearly rental of $1,000 per mile per duct and find that whatever is pulled in soon fails and has to be drawn out, the conduits will never be popular. Who can afford to use them? They will always be liable to explosions. The manholes being placed in the streets are receptacles for water and filth.

There are a number of conduits in Philadelphia made of wood and they have several times taken fire from the electric light cables placed in them, destroying the insulation of all the conductors In one instance a wooden conduit was set on fire from an unknown cause, it having no conductors in it.

The History of Electric Tanning.

In a recent article in *La Lumière Electrique* M. Rigaut says: "Like all other discoveries and inventions, that of using electricity in tanning is not a new one. About 1850 a currier named Crosse invented an apparatus to utilize what he called the 'effects of electricity or galvanism for tanning purposes.' Two electrodes were placed in a tan pit, one made of lead, the other of zinc. The pit was then filled with water and skins, and after an interval of three days tan was added in small proportions, in order to concentrate the liquor. Ten years later an Englishman named Ward, of Lancashire, made a series of experiments. Instead of electrolyzing the skins in water before adding the tan, he used electricity in the tanning baths. At Paris, in 1861, a M. Rebu invented a system of electric tannage. This is said to have been very complicated. The skins were treated with carbonic acid and hydraulic pressure, and then submitted to the action of salts of lime, of magnesia, and of iron. Currents of electricity were passed through the skins while they were immersed in the above mixtures and the usual tanning solutions. In 1874 M. de Mertens tried another system. At the bottom of a large vat was placed a layer of carbon, connected with the positive pole of a dynamo. On this skins covered with tan were placed. On the top of this heap a plate of zinc was placed, connected to the negative pole. The vat being filled with tanning liquid, the current was passed through. M. Mertens' system has been employed in nearly 600 pits for some years past at a tanyard in the environs of St. Petersburg, and by it about thirty-five days is required to tan the skins. In 1876, Gaulard and Kresser brought out another process, and in 1883 skins tanned by Gaulard's process were exhibited in England. In 1887, in Sweden, Messrs. Abom and Landin brought out a method for the use of electricity, and this has been in operation for two years at Noorköping, in Sweden, with good results, forty-five days being required for tanning. Some months before this Messrs. Worms and Balé, at Paris, had worked a process for the rapid tanning of skins by the aid of the electric current.

Proceedings of the Eighth Annual Meeting of the Street Railway Association of the State of New York.

The Association was called to order at the Powers Hotel on Tuesday, Sept. 16. President John N. Partridge, of Brooklyn, presided, and Secretary Wm. J. Richardson was in his place.

The delegates present were as follows: John W. McNamara, president, Albany Railway, Albany; Samuel Cowdry, president, Watervliet Turnpike and Railroad Company, Albany; Wm. Richardson, president, and Wm. J. Richardson, secretary, Atlantic Avenue Railroad Company, Brooklyn; Daniel F. Lewis, president, and E. W. Bliss, director, Brooklyn City Railroad Company, Brooklyn; John N. Partridge, president, Brooklyn City and Newtown Railroad Company, Brooklyn; Henry M. Watson, president, Buffalo Street Railroad Company, Buffalo; Porter Norton, director, East Side Railway Company, Buffalo; C. Densmore Wyman, vice-president, Central Park, North & East River Railroad Company, New York City; George Green, president, and Charles P. Emmons, secretary, Forty-second Street and Grand Street Ferry Railroad Company, New York City; Daniel B. Hasbrouck, secretary, Houston, West Street & Pavonia Ferry Railroad Company, New York City; W. R. Lambertson, president, and Sherman T. Pell, director, Pelham Park Railroad Company, Pelham; Arthur G. Yates, president, John N. Beckley, secretary, Arthur Luetchford, treasurer, and Norman McD. Crawford, assistant manager, Rochester Railway Company, Rochester; Charles Cleminshaw, president, and Charles H. Smith, superintendent, Troy and Lansingburgh Railroad Company, Troy.

There were also present J. H. McGraw; C. B. Fairchild and E. H. Chapin, *Street Railway Journal;* E. V. Cavell, *Street Railway Gazette;* Edward Caldwell, The Electrical World; F. L. Blanchard, *Electric Power;* J. L. Taltavall, *Electric Age;* E. E. Higgins and F. R Chinnock, of the Edison General Electric Company; Norman McCarty, of the Thomson-Houston Electric Company, and Frank A. Rogers of the Short Electric Railway Company.

The Treasurer's report was read and showed:

Receipts during the year	$1,104.06
Expenses during the year	781.43
Balance	$322 63

The report was ordered to be placed on file and spread upon the minutes.

The President of the Association then delivered his address, from which the following extract is taken:

Marked progress has been made since our last meeting in the substitution of mechanical and electrical devices for the propulsion of street cars in the place of horses; in New York city the Third avenue company is about to extend its cable system down town, through the busiest thoroughfares to the City Hall, this extension having been made possible by a recent decision of the Court of Appeals.

In many of our cities and towns where the electric car was unknown a year ago it is to-day a familiar sight. Its coming has been opposed by a few alarmists, who predicted that it would bring with it death and destruction. Similar predictions were made of the locomotive and even of the horse cars in their early days. But public convenience was served by both and their use has been marvellously extended. Wherever the electric car has been introduced it seems to have met with general favor.

Its noiselessness, its cleanliness and its capacity for attaining a high speed whenever a high speed is safe commend it to the riding public as a welcome substitute for the horse car, with the clatter of the hoofs and the slow jog of the horses and their offensive droppings.

Some of the brightest minds in this and other countries are actively working to develop improvements in the various systems known as the "conduit," the "storage battery" and the "overhead wire." Who will dare to say what they will accomplish, in view of the great progress made during the last decade in the telephone and in electric lighting.

What we, as street railroad men want, is a system which is simple and economical in its construction, in its adaptation to our existing equipment, and in its operation.

The introduction of the electric car, with its greater weight, creates a demand for a heavier rail and a more substantially constructed road. Inventors are looking after our needs in this direction and new patterns of rails and new methods of laying them are constantly brought to our notice.

The only paper presented to the convention was then read by its author Mr. John W. McNamara, of Albany, N. Y. This paper was as follows:

AN ELECTRIC STREET RAILWAY MOTOR.

Soon after the roadbed of the Albany railway was completed, and during the summer of 1864, when the directors and projectors of that road often saw four horses vainly endeavoring to draw the passengers contained in a 12-foot car up a grade of eight per cent. on State street, their attention was very naturally turned to the solution of the problem of transmitting the power of steam to the car.

Device after device was tried, but all proved failures; but still the directors never lost hope that at some time the problem would be solved. The successful use of the cable in San Francisco stimulated the stockholders to an effort to secure capital enough to construct a cable road; but the large amount of capital necessary to lay a cable road, and the want of faith in its working in this climate during the winter months, proved formidable obstacles.

More than twenty years had passed since the road was opened, and horses were still being used to draw the cars, when the attention of the managers of the road was called to certain experiments made by Mr. Leo Daft, who had for many years been a resident of two adjacent counties. Those of the managers who saw what the Daft electric motor did, felt that the day of emancipation for the State street car horses was rapidly drawing nigh. The experimental roads which are familiar to us all were earnestly examined, and the time when the obstacles to smooth operation would be overcome hopefully expected.

The time came much sooner than the most sanguine of us dreamed of; Baltimore, Scranton, Meriden, Richmond, Hartford and Boston followed in rapid succession, Scranton and Meriden demonstrating that it was possible to operate electric motors in winter. Our sister city, Troy, joined the electric band, and our sister company, the Watervliet Turnpike and Railroad Company, also contracted for electric equipment, before the Albany railway could determine which of the five systems was the best and make a contract. It was finally made with the Thomson-Houston Electric Company on the 30th day of November, 1889, and cars began running on the State street line April 28, 1890, and on May 1 all the horses on that line were withdrawn.

None of our drivers had had any training until the evening of April 27, 1890, yet we were able to begin running schedule trips with three cars the next day. Over four months' experience has taught us that the electric motor is efficient and reliable. We have yet to learn, by experience, that it will ascend State street, an eight per cent. grade, at the rate of five miles per hour in winter, as it has during the summer. We have also to learn by experience, for it seems to be impossible to learn it in any other way, whether operating cars by electricity is more economical than by horses.

At the time of the introduction of the electric motor, the ordinary street car drawn by horses was the most convenient vehicle in public use. It was easy to enter one and easy to alight from one. The various makers had vied with each other until one was able to step as easily from the street into a car as he could ascend two steps of his own stairs. The early builders of electric cars endeavored to retain this feature of the street car, and placed the motor proper *on* the car, communicating motion to the axles by means of sprocket chains and wheels; but the mechanical difficulties and the noise made by the chains and wheels led to their abandonment, and the motor or motors were then placed on the axles and *under* the car, where we find them to-day.

At first the easy-of-access feature was retained, but as the necessity for larger motors and more room for them became apparent, the car body was gradually raised until it is too high for children and elderly people to enter readily, and a great deal of time is consequently used in receiving and discharging passengers.

The car body has been raised at the expense of comfort, without, it seems to me, improving the condition of the motor. It is still under the car near mud, dust, snow and slush, and is as difficult to get at as it ever was.

With these exceptions the electric motor of to-day is well nigh perfect, but these exceptions, as time goes on, will become more serious. When the novelty of being regularly and rapidly carried to their homes and places of business ceases, then passengers will call attention to the difficulty of entering and leaving cars.

The size of the motor, especially for use on grades, should not exceed the standard—16 feet for box cars and about 25 feet for open cars. On level and suburban roads, where the headway is not less than twenty minutes, larger cars with eight wheels might probably be economically used; but for populous cities where headway is less than five minutes, the old standard car body is, in my opinion, the best.

How the motor is to be arranged with reference to the car body so as to admit of easy access to it for examination and repair may, or rather must be left to mechanical and electrical engineers. That we will continue to drag them in the dust and mud very long I cannot believe.

I think the opinion of all who are unprejudiced is, that the overhead single trolley under contact systems are the most reliable and efficient. With good overhead construction the loss of power in transmission is but slight, and the conductors are always where they can be seen and kept in place.

The ideal motor is one which is independent of every other motor or other engine, and contains everything necessary to make it go. This motor exists and seems to work fairly well on grades of not more than five per cent.; but that it is capable of doing the work now being done by motors of overhead systems is still problematical. However, as we have already witnessed such wonders in propelling cars by electricity, may we not hope for a storage battery electric car which shall be equal to any now in use?

We are justified, I think, in recommending to all who think of changing from horse to electric motors, or to all who think of building new roads, the overhead single trolley system. All the manufacturers of motors and generators have their systems in use in cities which can be readily visited, and the merits of all can be compared.

The question as to whether the electric motor is as economical as the horse car cannot yet be answered and need not be answered. Just as certainly as the horse car supplanted the omnibus, the electric motor will supplant the horse car. The horse car, however economical, must go and the electric motor, no matter how expensive, must come.

Mr. Frank A. Rogers, representing the Short Electric Railway Company, of Cleveland, opened the discussion, as follows:

Mr. Chairman and Gentlemen: I desire to say a few words in behalf of our system, and to call the attention of the gentlemen to some of the principal points of our motors, in the armatures especially. We use an armature that is large in diameter, and which is run at a slow rate of speed. When the car is running at the rate of 12 miles an hour the armature revolves about 1,000 revolutions per minute. We use very large pinions, 6½-inch pinions, which are made of the best machine steel; the large gears are made of cast steel, and have wooden webs between the rim and the hub, which are put there for the purpose of deadening the noise, and also to serve as an insulation—insulating the motor itself from the ground; the ground connection being made directly from the motor to the car axle by flexible cable connectors. The axle part of the motor itself is insulated by heavy wooden beams, connecting the motor with the axle portion. We do that in order to deaden the noise and to get perfect insulation from the ground to the armature. The "series" system has been practically abandoned by our company; we are now using what is known as the parallel system, similar to that of the Thomson-Houston and Sprague; that is, in connection with the distribution of current and the style of overhead construction. The Short motor differs greatly in mechanical construction and electrically from any other. The field magnets, which are four in number, are "series" wound in one coil on each magnet, and the coils on the armature are entirely separate from each other. If one of the coils should happen to burn out it does not touch any other coil on the armature, and is very easily repaired, on account of there being very little of it. We have a great deal of apparatus here in Rochester at present. It is mostly in boxes in store houses. The company has been hindered somewhat in getting its construction under way and its poles set up, and this has caused some delay in starting our cars in operation here.

Mr. Lewis, of Brooklyn: What is the reason of your abandonment of the "series" system or principle?

Mr. Rogers: It was not a success with a large number of cars.

Mr. Lewis: Why was it not a success?

Mr. ROGERS: The trouble came in the generators. It is a success with two or three cars, but with from five to a hundred cars it is not so successful. We think the parallel system is better.

Mr. LEWIS: I understand the series system to be composed of a main conductor carrying the current of electricity, and being shut off in sections. That you say is not successful. How does it act generally?

Mr. ROGERS: Not well with a large number of cars.

Mr. LEWIS: You say it acts unfavorably on the generator. I understand that the abandonment of the system is because it acts unfavorably upon the generator. Is that due to any great complication through this series system?

Mr. ROGERS: The trouble is that it is a hard matter to manufacture what we call a constant current generator. It is almost impossible to manufacture a generator that can be operated with little attention. The motors work fairly well on small roads. They are in successful operation at Huntington, Va., and Columbus, Ohio; but you understand that for a large number of cars it is not so well adapted as the parallel system.

Mr. LEWIS: My idea was to bring before the meeting the reason for the abandonment of the series system and the preference of the parallel system. The parallel system seems to have been generally adopted. The generator, you say, throws a constant current from it into the conductor. You cut off the current by the series system, and put it on by some action. Does that make an uncertain return, so that it throws the generator out of gear?

Mr. ROGERS: It fluctuates so that the generator does not take care of the current. In the parallel system the electromotive force is constant. In the series system the current is not constant, and in that way it is not adapted for a large number of cars. And then the construction, the overhead work, is more complicated, a switch being used in it, and the cars could not be bunched, that is a number of cars in the same section. Professor Short has been through that very carefully, and has spent a great deal of money in trying to work the system up and make it a success, and has also experimented largely in underground work before the new company was organized, but since the organization of the new company the parallel system has been adopted.

Mr. LEWIS: Mr. McNamara's report suggested the single wire under contact system. Do you prefer that to the double return?

Mr. ROGERS: Yes, sir; single overhead wire and rail return.

Mr. LEWIS: What is the reason?

Mr. ROGERS: It is not so complicated, and in a large city where there is one line crossing a number of tracks it lessens the number of wires overhead. At Cincinnati we were obliged to put in the parallel double overhead wire, on account of the telephones there and the street railway managers being largely interested in the telephone companies.

Mr. RICHARDSON, of Brooklyn: Why?

Mr. ROGERS: To overcome induction in telephones. At the time we didn't care to put it in, but they desired it, and seemed to be perfectly satisfied with it, and we took the contract to put it up. There is only one other company in Cincinnati, the Thomson-Houston, using the double overhead system. The Sprague, I believe, is using the single overhead.

Mr. LEWIS: I understand the objection by the telephone companies to be that you do not get a full return of the waste current through the means you employ for that purpose. It goes through the earth, and is attracted by their system and gives a buzzing sound to the telephones.

Mr. ROGERS: That is not in all cases; it depends on the distance their ground return is from the street car circuit.

Mr. CLEMINSHAW, of Troy: Will you not give us an idea of your line construction as differing from the Sprague or Thomson-Houston?

Mr. ROGERS: In the parallel system we use practically the same plan and principle as in the other systems that are parallel. What is meant by "parallel" is that the cars are in a circuit, so that the current equally divides through each car as the amount of current is required to drive it. In the "series" system the same amount of current all passes through each car. It does not equally divide. For instance, a quantity, say 40 ampères, all goes through each car, where in the parallel system it divides equally through each car. If you have a generator that is producing 160 ampères and you have five cars on the track, each one of the cars takes its proportion of current, and it may not be all of the output of the generator. It depends, of course, on the road, grades and load being carried.

Mr. CLEMINSHAW: Give us some idea of your line construction as you propose to put it up here in Rochester.

Mr. ROGERS: As I said before, it is parallel, and we use feeders in our construction work. We do not use or employ solder where there is a strain on the line. The connections are all mechanical. We have a patent device for making connections of the trolley wire splices without using solder.

Mr. CLEMINSHAW: I understood you last evening to say that you insulated your trolley wire at points on the line. The Thomson-Houston has no such system as that. Will you please explain that feature of your system which is different from other systems?

Mr. ROGERS: The idea is that we can "feed in" from one feed wire running the length of the line, divided in sections, each section being insulated from the other; that is, the trolley wire. Of course that depends on the length of the road and number of cars to be operated. This wiring has all to be figured for carrying capacity and equal distribution over the line, and what one road would require another road would not in that respect. On some lines we do not use any feed wire at all.

Mr. LEWIS: I think you just said that you feed in from your feed wire into a sectional trolley wire.

Mr. ROGERS: Yes, sir; where we use only one feed wire, that is also parallel, so that while a car is going through a section it is merely using current in that section, and after the car has passed that section there is no current running through. The other plan is to use a number of feed wires running along and feeding in, without the trolley wire or trunk line being in sections.

Mr. CLEMINSHAW: I understand your trolley wire is really a trunk wire.

Mr. ROGERS: In that case it is.

Mr. RICHARDSON: I ask whether in your judgment, Mr. Rogers, what you have said in regard to five cars in operation on a road is just as applicable to a system of fifty cars running three minutes apart over a road from four to five miles?

Mr. ROGERS: Yes, sir. You understand that all the variation in the wiring for different places must be figured out for the several carrying capacities of the roads and for equal distribution over the lines. There are hardly three cities out of five that have the same wiring and the same size and feed in at the same place.

Mr. RICHARDSON: What is the minimum and maximum size of the wires used?

Mr. ROGERS: Any wire from 00 up to 5.

Mr. MCNAMARA, of Albany: If you can give the diameter in inches it would be better.

Mr. ROGERS: I should think the number 00 was three-eighths inch, perhaps number five would be about one-eighth inch or in that neighborhood.

Mr. E. E. HIGGINS, of the Edison Company, spoke as follows: The Sprague Company is now a part of the Edison General Electric Company. There is one point I want to mention first, and that is that at 3 o'clock on the 4th day of September, 1 82, the old Pearl street station of the Edison company started out. On Jan. 2, 1890, it burned out from an accidental spark. Between those two dates that station turned out current 24 hours in each day without stoppage. I mention this for several reasons. In the first place, it ought to do away with some of the objections that have sometimes been raised to electrical systems on the part of the public on the ground that it is not reliable. The generation of electricity is reliable. When the first station of the kind ever built can run for nearly eight years as that station did, it is true that the stations that are now built can do even better work. The old Pearl street station settled this fact, that you can take coal, turn it into steam, turn it from steam into electricity, transmit the electricity through an expensive underground system of conductors, and can turn it again from electricity into light at a price which will compete with gas made from coal. That is an example of the advantage of steam and electricity over even steam, which has made the electric railway what it is to-day. It costs to run a car by electricity, for the "provender" (coal and water) about seventy-five cents, and to feed eleven horses for the same service, same number of hours per day, it costs a little over two dollars a day. You can see again that there is an enormous intrinsic advantage of steam and electricity over horses. The Edison Company proceeded with the electric light business, and about 1885 or 1886 Mr. Sprague, who was then with the Edison Company, came out with his electric railway system. The principal things brought out by Mr. Sprague and copied ever since were the placing of the motors underneath the cars and attaching them to the axles on one side and to a spring support on the other, and this spring support was the one feature which enabled the Sprague Company to use spur gearing. Previous to that time sprocket wheels and chains and worm gearing had been used. Spur gearing had been used and discarded, for the reason that the lack of flexibility in the motor caused the strains put on the gearing to be so severe as to strip the teeth and cause other difficulties. Then the control of both motors of the car from either platform was another important point. The claim to the conception of the under running trolley, I believe, is disputed; I presume it is one of those early contrivances, which may have been brought out by others at the same time. It has been adopted everywhere, and is the only true way of getting at the thing. The method of winding the Sprague field magnets is entirely different from all others. They are wound in three sections each; the coils are wound on spools, and the spools are slipped on to the fields, and the control of speed is effected by different combinations of these coils without the use of wasteful resistances. In some of the systems there are different contrivances in use for varying the speed from zero to the full speed. Resistances are put directly in series, and are gradually cut out, as the speed of the car increases, allowing more current to go through the motors. The Sprague Company does away with this wasteful resistance by throwing this current, which produces different effects on the motor. The consequence of this is that the cost of coal per car is less, we claim, than with any other systems. I think the claim is admitted. That means a reduction in the operating expenses; it means also a reduction in the original cost. If you can run 100 cars with 750 h. p. in dynamo and engine capacity, it is plain it will be less expensive than it will if it takes 1,000 h. p. The original investment required is, therefore, less than it is with other systems, because the apparatus required is less. The operating expenses are also less. These are the main features of the system.

Since the 1st of August Mr. Edison has been devoting his entire attention to some changes in the motor. They are merely as to mechanical details. The feeds of the motor are now spread slightly so as to allow a little more wire on the field coils, and to vary somewhat the amount of metal in the machine. This makes a somewhat more powerful machine, and in some respects improves the design. The gears have been widened; but the most important advance which has recently been made in electrical railway work is the adoption of the new styles of winding the armatures. The old armatures of all systems, with the exception of the Short system, are wound in what is called the Siemens winding, the wire being put on in such a way that at the end of the armature there is a large bunch, the wires of which cross and recross each other, and not being firmly fastened in place, there is necessarily some chance for the play of the wires; and this results in the fact that the armatures frequently burn out, as we know. The first effect of this method is that you may have a maximum pressure wire touch a zero pressure wire, and the slight motion between these two will cause the insulation to become abraded, and a short circuit on one or two coils will follow. In the new armature that we are bringing out there is no bunching of wires at the end. The coils are wound separately, are inexpensive, and may be replaced easily. In the event of one of these coils burning out, the method of repairing the armature would be to loosen up the coils, withdraw the coil that is burned out, and replace it by another, the whole operation occupying but a few hours. In the old form the wire is wound in two layers, one over the other. These layers are usually broken, in accordance with the law of things, on the lowest layer, so that you have to unwind the top layer and a good part of the lower. The new winding does away with this entirely. As a matter of fact, we believe our armature will not burn out, except it may be caused by an actual overloading which will melt out the wires. The coils are insulated from each other by fibre insulation. We belive the only cause of burning out in the future will be the overloading of the armature. There is another point, in regard to the car, which ought to be mentioned. In times past there has been some criticism as to the sudden starting of the Sprague car. This is largely a matter of manipulation on the part of the driver, and it is also partly due to the method of winding. Difficulties of that nature have been entirely done away with by the adoption ot what we call a slow starting device. It is put in the very instant the car starts, and this resistance is cut out immediately and is not in circuit at any time during the operation of the car.

Mr. LEWIS, of Brooklyn: This contrivance is practically a governor; it governs the amount of electricity that goes into the motor.

Mr. HIGGINS: Only for the instant of starting; it prevents too much current going into the motor. When the crank reaches the first notch, then the regular system of operations of the fields commences and is afterward carried out. The switches on the Sprague car are fire proof; this is a new device recently put on.

The feeding-in system, as it has been called, is distinctively and exclusively an Edison-Sprague invention. The system is this: We have a trolley wire in the centre over each track, the wire being about as large as a pencil. It is made of a composition of copper, and has a tensile strength equal to that of drawn steel, while its conductivity approximates to that of copper. It carries only the portion of current used in the actual operation of the car at a given point. The main current is carried by heavy copper feed wires. In the first place, we have the main conductor, which passes along the whole line. That is connected at intervals with a specially insulated auxiliary feeder, as we call it, which maintains the pressure all the way along the trolley wire. The car takes from this feeder the current that is required to operate it until it comes on to the next. By our arrangement of feeders we lose ten per cent. only, and frequently less, in the entire overhead structure. Thus, of one hundred horse power coming out of the station, ninety will go into the cars along the line. You cannot obtain this by the use of a single trolley wire carrying the whole current. I have heard of one case, where that system was adopted, where the pressure fell from 500 volts at the station to 250 volts at the car.

Mr. LEWIS: This feeder system, in connection with your main conductor, means that you can maintain a uniform speed of the car, regardless of grades and loads; furnishing the trolley wire, through the feed, with whatever electricity is required?

Mr. HIGGINS: We never advise the running of car on a heavy grade at full speed, 12 miles an hour. We could arrange to do it, however.

Mr. LEWIS: I asked if it was possible to do that, in view of the fact that an electric railway company might be in competition with a steam road.

Mr. WM. RICHARDSON, of Brooklyn: What speed do you recommend on a grade—say, six or seven feet to the hundred?

Mr. HIGGINS: About eight miles an hour can be attained.

Mr. RICHARDSON: Faster than a pair of horses would be allowed to travel on the level?

Mr. HIGGINS: Yes, sir; I think so. One other point ought to be mentioned: we put up our line in sections. Every two or three thousand feet, more or less, we break the trolley wire, making each section entirely distinct from the others. A trolley wire section is fed from the conductors on the side, and is fed through fusible "cut-outs," which, when the current in that line exceeds a given amount, will melt and cut off the entire section of the trolley wire from the source of electricity. In case of accident or fire a rope can be thrown over the line, and the instant it touches the ground it is dead and there is no more electricity in it. It can then be taken up and put out of the way.

Mr. NORMAN MCCARTY, of the Thomson-Houston Company, said: The Thomson-Houston Company have long recognized the fact that the electrical railway apparatus is not so much an electric as a mechanical problem. We have aimed to get it as simple as possible. We use no commutated fields. We made up our minds that it is a good deal better to spend a little more money for coal, and avoid wear and tear, and we are convinced that we have done the right thing. Quite a number of gentlemen here know as much about our system as I do, who use our apparatus. Our motors are plain series wound. We use the much abused rheostat. The peculiar advantage of this is that we can start our cars without jar. You can hardly tell when it starts, the starting is so quiet and steady. We can make a good deal better time because of this, not having to wait for old people to be seated. We rarely burn a field, and there is no particular reason why we should have any more trouble with our armatures than other people. There is no reason why our field should burn out, because all changes of resistance are made by the rheostat. I believe that other companies claim that with the divided fields they save coal. We do not care so much about that, as the increased amount of coal is not excessive. We save wear and tear and get rid of annoyances. Our latest construction is perfectly simple. Regarding line construction, I would say that we are not limited by any patent, the method of construction varying with the conditions of the circuit. There is a patent on a system by which you feed your line at regular intervals; there is no patent on the system by which you feed at irregular intervals.

The impression has got abroad that the Thomson-Houston Company is high-priced in its charge for electrical apparatus. It seems to me that it is not so much a question of how much per car as it is how many cars you have got to pay for. If you can operate a road with only one or two per cent. of cars out of service, you can afford to pay more per car than if you have 15 per cent.

Mr. RICHARDSON: Will you please tell us what is the superior advantage of the Thomson-Houston over the Sprague system, which makes it economical for those who have to buy to pay the higher price?

Mr. MCCARTY: I do not know that I can do that without criticising the other systems. As for the Thomson-Houston Company, our cars and trucks are heavier; motors are heavier and built stronger; the gears are wider, and we have eliminated most of the electrical complications. We do not care about a complicated electrical theory, so much as the mechanical perfection. I think that is the secret of our success.

Mr. RICHARDSON: I ask purely for information. I represent several companies that are contemplating the purchase of electrical apparatus, and have not purchased the first thing yet.

Mr. HASBROUCK, of New York: Two years ago we were invited to take a ride over the Thomson-Houston road in Washington. I would like to know how that road is working?

Mr. MCCARTY: It was the first road we started, now

nearly two years ago. I think if you were to talk with the president of that road he would, I believe, tell you that he has the best electrical road in the United States. You can probably get more information from those who are using the system than from me. We consider the electrical railway problem a mechanical one. We do not use a large armature, we use a small one; and we use it for good reasons. We do not use a small trolley wire, we use a greater one; and we use that for good reasons. Our reason is that it has a larger conductivity. The silicon bronze has about 60 per cent. of the conductivity of pure copper; our hard drawn wire has about 80 per cent. We use a trolley wire which has about four or five times the sectional area of the silicon-bronze wire, consequently we get a larger conductivity on that account. We get rid of feed wires along the side of the street. There is more objection to the wires on the side of the street than through the centre. We do feed our lines, but we do not break our circuit, except on extended and complicated circuits. We use the trolley wire as a conductor, and only feed where it is necessary on account of special grades.

Mr. RICHARDSON: I would like to call the attention of the members to the fact—it may be known to many of you, and may be known to but few—that the Boston *Daily Advertiser*, one of the most conservative papers in this country, sent out a letter asking information from all cities, from Portland, Me., to Galveston, Tex., in which electric railways are operated, inquiring what systems they used, whether there had been any loss of life in connection with the wires, whether there was any objection to the overhead system on the part of the public, and what had been the effect on the street railway service of the particular locality. They published these answers, so far as they have received them, from 64 different places. All but four of them were favorable to electricity. Nashville, Tenn., I think was the only place where there was any loss of life reported. The answer from that city was rather amusing. There had been a wire broken in that city, causing the death of a horse, and a negro woman caught up the wire and threw it over, and it gave her a shock that was very amusing in its effects, but it did her no injury. It killed the horse, but it did not hurt the woman, going to show that it is easier to kill a horse than it is to kill a human being. Another objection came from Newport, R. I., where the upper ten were objecting to anything which should popularize riding. The mayor of Rochester responded favorably, as also did the mayors of Troy, Buffalo, and Albany.

Mr. F. R. CHINNOCK: I have been connected with the Bell Telephone Company, of New York, the Bell Telephone Company, of Boston, and the New York and New Jersey Telephone Company. I wish to say a few words about this matter of induction. The telephone companies say they cannot do away with induction; that is all wrong. They can do away with it, if they will only go to expense. The method is well-known. They should provide a return metallic circuit.

Mr. CLEMINSHAW, of Troy: We were threatened with injunction suits by the telephone companies. We kept them off until the accidental discovery was made in Albany of a method of overcoming this interference. We put down two supplemental wires, connected them, and run them through to the station. The thing has worked very effectively, and is an inexpensive method of overcoming the trouble referred to.

Officers for the ensuing year were elected as follows: President, Daniel F. Lewis, Brooklyn; first vice-president, John N. Beckley, Rochester; second vice-president, John S. Foster, New York; secretary and treasurer, William J. Richardson, New York; executive committee, John N. Partridge, Brooklyn; Charles Cleminshaw, Troy; C. Densmore Wyman, New York.

At 1 o'clock an adjournment was taken, after which the members had luncheon at the Rochester Club house. A trip to Charlotte over the electric road followed. In the evening the members were entertained at the Genesee Valley Club house. The entertainment of the members while in the city was conducted by Secretary Beckley of the Rochester Railway Company.

The next meeting of the Association will be held at the Hotel Metropole, New York, the third Tuesday in September, 1891.

Minneapolis Meeting of the Association of Edison Illuminating Companies.

SESSION OF TUESDAY.

The session was opened by President John I. Beggs at 11:30 Tuesday, Sept. 16, who explained that the session had been postponed by action of the Executive Committee suspending the clause of the by-laws providing for the holding of the annual meeting on the second Tuesday in August, on account of the holding of the Exposition during the present month.

An interesting discussion arose upon the results of the burning of arc lamps on Edison circuits, during which it appeared that the trial of this method during the past few months had resulted very satisfactorily to the companies whose experience was quoted.

At the afternoon session Mr. Insull, second vice-president, made interesting and important explanations of the status of the patent suits now being pressed by the parent organization, and the recent consolidation of all the licensed manufactories with the general company. By this statement it appears that the effort will be to furnish electric light and power apparatus of any variety of the most approved character and at low prices in competition with any other of like excellence on the market. It is also the purpose of the company to furnish an Edison motor, and thus by the keeping of a stock of armatures and other supplies at each of the district centres, render it more easy for the companies to secure promptly anything of this kind than heretofore. Also that Mr. Edison, who was unavoidably detained at the laboratory, is and will in the future be actively engaged in perfecting the present and developing new apparatus in the field of electric light and power.

A discussion of the effects of crosses from high pressure circuits with Edison three-wire conductors developed a great interest, and a report from Wilson S. Howell, who has for some months been gathering statistics, showed that in no case thus far noted has a cross with a high pressure direct or alternating circuit proved damaging to the Edison wires or apparatus. A committee was appointed to further investigate this subject with special reference to the possible future interference of electric power systems, such as railways. The committee was appointed by the president, as follows: C. P. Gilbert, Detroit; Wilson S. Howell, New Brunswick, N. J.; C. L. Edgar, Boston; H. Ward Leonard, and J. H. Vail, New York.

The recent improvements in the Edison electric meter and the development of a new mechanical (registering) meter formed the subject of two papers from A. E. Kennelly, of the Edison laboratory, and R. S. White, of the Edison Electric Illuminating Company, of Brooklyn, N. Y. In these it appears that the perfected Edison chemical meter has been shown by a year's experience cheapened and rendered about three times as accurate as formerly by the improvements noted at the meeting of a year ago. and that Mr. Edison has constructed a meter in accordance with some of his earliest ideas on this subject, which is expected to prove cheap and reliable for small currents, probably up to 20 or 25 lamps. Mr. Kennelly's paper was as follows:

ON THE NEW STANDARD EDISON ELECTROLYTIC METER.

Since the last meeting of the association the new and improved pattern of the Edison meter has been decided upon, received Mr. Edison's approval, and has been completed by the Edison General Electric Company. It has already been introduced into two stations, Brooklyn and Winnipeg, and the reports upon its behavior in each case are excellent.

There are four standard sizes of these three-wire meters. Nos. 1, 2, 4 and 8, designed to supply 40, 80, 160 and 320 lamps, respectively. Meters of larger capacity than these are made specially. In all sizes, however, the bottles and plates are alike, and of the patterns shown, the spools are alike, making the resistance of the bottle circuit the same in every meter, and the drop of potential in the shunt at full load is the same, namely, four-tenths of a volt.

It is arranged that in the smallest, or No. 1, meter each milligram of weight transferred represents one ampère hour of supply, and the transfer is 10 milligrammes per hour on full load. Similarly every meter transfers 10 milligrammes per hour at full load, so that each milligramme of transfer in a No. 8 meter represents eight ampère hours, and in a No. 4 meter four ampère hours, the number of the meter being the index of the supply in each case.

This greatly simplifies the system, reduces the weight of bottles that have to be daily transported, reduces the stock that the station has to keep in hand, makes only one balance requisite instead of two, and with reasonable care the use of a separate multiplier for each size of meter is not found to be an inconvenience. The objection has been urged against the system that there is danger in making one milligramme of transfer stand for so large a unit as eight ampère hours in the No. 8 meter, since an error in weighing or in the proportions of the meter would result in an error in the bill eight times as great as the same discrepancies would produce in a No. 1 meter. Even granting the validity of the objection, however, it is evident that since meters are introduced in the capacity proportionate to their duty, the error in the No. 8 meter bill will only bear the same ratio to the whole amount charged that the smaller No. 1 error bears to its bill. As a matter of experiment, however, taking for instance a series of tests made with the meters made by Mr. R. S. White, at Brooklyn, the records of a set of No. 1, 2, 4 and 8 meters worked in series and at intervals for a week on half load for the smallest, or five ampères, one-sixteenth of the load for the largest, showed practically the same result, the No. 8 meter under indicating about two per cent.

This high degree of relative accuracy, setting aside all questions of care and skill, is secured by three things. The first is a higher degree of absolute accuracy in general. The old pattern meter is universally admitted to be a faithful and accurate instrument, but the intrinsic accuracy of the new pattern is about three times as great. The only chance for error in the operation of the electrolytic meter, accidents aside, is the variation of resistance in the bottle whereby the true ratio between the currents in the bottle and shunt circuits is upset. The extent of such a disturbance of course depends upon the relative proportions of resistance in bottle and spool. Suppose it were possible for the new bottle to even double its resistance, and to become five ohms instead of 2.5 at normal temperature. In circuit with a spool of 46½ ohms, such a change would only upset the balance and make the record in defect five per cent. In the old pattern meter, the doubling of the bottling resistance, were such a variation to be expected, would make the readings 15 per cent. in defect.

The second preventive of error in the larger sizes is due to the uniformity in the size of plate. A cause of discrepancy has always existed in a slight gain of the plates in weight independently of the current's action and due to their oxidation superficially. With care this source of error has always been minimized, but with the old meters it increased with the size of the meter, since a larger plate offered a larger surface to oxidization. In the new pattern it is of course a fixed amount in all sizes, and owing to the small area of plate is in any case very small.

The third precaution against error in the larger sizes is the use of duplicate bottles in the Nos. 4 and 8 as mutual checks which are not required in the Nos. 1 and 2.

Another improvement is in the plates. These are castings of pure zinc alloyed with two per cent. by weight of pure mercury. This amalgam has the advantage of being more readily brought into good condition for use than the rolled plate; the trouble of varnishing is also saved.

The only other noteworthy change has been in the solution, which is about twice as dense as in the old bottles.

Mr. Edison has recently completed a mechanical meter on the pattern of one of his early patents in that direction. This instrument is a small motor delicately constructed. The armature commences to rotate as soon as one lamp in the supplied circuit is turned on. The rotation accelerates as more lamps are lit until at the full load of 20 lamps the speed is 600 revolutions per minute. A counter worked from the armature shaft records the number of rotations, and on duly proportioned dials the supply. The field magnets are kept charged by a feeble current from the mains, while the main current passes through a shunt as in the electrolytic meter, and from the shunt terminals wires pass to the armature. The drop of potential in the shunt at full load is 1.5 volts. The model, though complete in itself, will be slightly modified in detail to suit commercial use, and will then be available for such cases where a mechanical meter is desirable. Mr. Edison does not consider that a mechanical meter can possibly be as cheap or as reliable as the electrolytic meter, first, owing to the necessary frictional error which makes the record too low for very light loads and low speeds, and, secondly, owing to the mechanical wear and tear of the working parts which will need attention and exchange from time to time; but there are cases in which a direct reading mechanical meter will be an advantage and he expects that from the tests and behavior of this model it will serve the purposes.

Information concerning these new meters can be obtained from the Engineering Department, 16 Broad street, New York.

Mr. R. S. White's paper was as follows:

CONCLUSIONS DRAWN FROM ONE YEAR'S EXPERIENCE WITH THE STANDARD EDISON METER.

During the year's work with the new standard meter we have taken 4,088 incandescent, 853 arc light and 244 motor readings, a total of 5,185, and have obtained uniformly good results. In a large number of cases customers have kept tally of lamp hours, and in every instance expressed themselves as satisfied. A considerable number of tests have shown marked accuracy. The greater dispatch and care with which the meter work can be performed has been abundantly shown. The use of small and uniform plates secures, by the balance method, double accuracy in weighing and the elimination of the oxidation error. In brief, our experience with the standard meter shows improved ease and economy in operation with more uniform and accurate results. In so far as a chemical meter "fills the bill," little remains to be said.

It may be interesting to note the use of four Aron meters on our circuit for the past year. The frank, open countenances of these meters have won the favor of the meter man and the confidence of his customer. It is suspected also that the company would accept their advances with better grace were it not for their haughty treatment of the financial question involved.

We may conclude then that it is in the line of a direct reading dial meter that we are to look for the next advance in the commercial treatment of the new meter question.

A report by the secretary on the "Grounding of the Neutral Wire in Three-wire Systems" was read, and assigned for discussion on Wednesday.

Special assignment of the questions of central station insurance and the proposed national code of insurance rules for electric light and power work was also made to Wednesday at 10 A. M. A paper on "Comparative Statistics on Electric Lighting in the United States" was read by F. R. Upton, of the lamp department of the Edison General Electric Company, and excited an interesting discussion.

Adjournment was made to the Director's room of the Industrial Exposition building where an evening session was held at 8:30 o'clock.

SESSION OF WEDNESDAY.

The convention was called to order by the president, Mr. John I. Beggs, at 10:30 A. M. Delegates not noted in the list of the opening day handed their credentials to the secretary, H. G. Balkam, Edison Electric Illuminating Company, Brockton, Mass.; E. A. Hammer, lamp department, Edison Electric Company, New York.

By special assignment, the question of insurance was made the first order of business. The special committee on insurance of central stations, consisting of Messrs. C. L. Edgar, Thomas P. Merritt, W. J. Jenks and John I. Beggs (ex officio), reported substantially as follows:

This committee, which was appointed about a year previous to investigate the feasibility of some plan of mutual central station insurance, made a somewhat careful report at the Niagara Falls meeting last year, and subsequently in the minutes of that meeting made an additional report from material gathered after the meeting, by which it appeared that the published proceedings of the Niagara Falls Convention had stimulated, at least in one direction, healthful action upon the subject of this mutual insurance of central stations. In one of the appendices to the report there was printed in full a prospectus of the Electric Mutual Insurance Company, of which Mr. S. E. Barton is the president. That brought the matter up to so late a date, and outlined so clearly to the committee the probability of a fruition in the direction of their work without any further effort on their part, that the committee have not considered it necessary to render this morning any formal report, but merely to call attention to the fact that this prospectus of the Electric Mutual Insurance Company was followed up by the projectors of that enterprise in the development of an organization and the beginning of business, with which facts most of you gentlemen are more or less familiar: and the committee desire, in view of the mutually useful and profitable results which appear to be coming forward, in the interests of the central stations, to report at this meeting that their work has practically been accomplished, so far as they understand their instructions. The committee also decided that, as Mr. Barton was in this vicinity, they would secure from him a statement somewhat in a historical way, and somewhat in explanation of the business methods of the Insurance Company in which we are all interested or likely to become interested, so that we might receive in a more intelligent way than could be otherwise devised by the committee the whole sum and substance of what its work has resulted in. I am very glad to say that Mr. Barton is, by special invitation, present with us this morning, and he will supplement this informal report of the committee by important facts and figures which the committee would not be able to present.

The President then introduced Mr. S. E. BARTON, who made, in substance, the following remarks:

I am indeed grateful for the privilege extended to me of meeting you all here in this session. I do not feel that I have come as a stranger, nor brought to you any scheme that any one is particularly interested in. I feel, and I want you to feel, that in this system of insurance all of you who may become insurers will become owners, as it were, and I, occupying simply the position of being the head of the company, your servant.

By this system of insurance there is no profit. There is nothing to be gained by any person, with the exception of course of those engaged in its business management, who may receive a salary. The system is to deal directly with the insured—with the owners of the property themselves—and not by a system such as is carried on by the stock insurance plan.

It might be well for me to say a word in this connection in a historical way. I have been connected for about 16 years with the insurance interests of the country, being ten years with the stock companies of New England, and I have had for a number of years the idea that in view of the unjust discrimination against electric light risks by the insurance companies, the electrical interests should have a system of insurance of its own. I am aware that while there is a strong prejudice in the minds of the underwriters against electrical risks, that prejudice has been due absolutely to their lack of knowledge, and to a few fires that occurred

in consequence of the early imperfect construction. I did not, however, take any steps in the matter or intimate my views to anybody until I chanced to see the work of Mr. Jenks and your committee. I immediately communicated with him; the result was that we went to work and formed a prospectus, which was submitted at a meeting in Mr. Beggs' office in New York City last fall, and that was the beginning of the Electric Mutual Company. Copies of this prospectus were at once sent out, and we received such flattering responses to it from all sides that we went to work and organized a company in Boston in April last. We began business on the 15th of May by issuing policies and putting on our books such risks as we could secure immediately to make a beginning. We have in four months secured and put upon the books of the Electric Mutual Company nearly $2,000,000 worth of insurance. About $300,000 of that has been upon first-class manufacturing property; $1,700,000 has been written on electric stations.

As soon as we started with the company several of the manufacturers' mutuals of New England, who had up to that time written very sparingly upon electric stations, having insured perhaps 15 or 20, and met with but a single loss (Fall River), came to me and desired to co-operate with us. These companies were the Mercantile Mutual, of Providence, together with the Enterprise and the American Manufacturers' Mutual of Providence, also the Cotton and Woolen Manufacturers' Mutuals, the Rubber Manufacturers' Mutual, and the Industrial Mutual, of Boston. They had particularly expressed themselves as being willing to undertake the insuring of central stations, particularly those operating the Edison system, if the Edison parent company would undertake the electrical supervision of those risks. That was, of course, something that no parent electrical company would want to do, but the question was entirely settled by the formation of the Electric Mutual. Then they announced that they would be entirely satisfied with our selection and supervision and were very willing to write policies on any station partly insured in the Electric Mutual, and I am very happy to say that to-day all of those companies are co-operating with us.

We have up to the present time turned into them surplus insurance that we are not in a position to absorb ourselves amounting to something like $400,000 on the larger stations, and they in turn have reciprocated by turning over to us about $350,000 upon their risks, particularly those having isolated plants, requesting us to undertake the inspection of those plants, and offering to give us sufficient business to warrant us in doing the inspection. This makes the alliance between the different mutual insurance companies and the Electric Mutual all that could be desired, and we are to-day in a position to provide for any amount of insurance on electrical risks that may be offered.

Permit me in a few words to explain the system of insurance which we have adopted, and the basis upon which we have made our calculations. It is not an untried field with us by any means.

We have the experience of the manufacturers' mutuals covering 40 years or more, in insurance upon manufacturing property, of what might be called "standard" manufacturing property, having the best of construction, the most efficient fire appliances, automatic sprinklers—in a word, all modern fire appliances. We have also the experience with this class of risks in the early days when construction was more imperfect and the very crudest fire appliances were in use, so that we are able to form an intelligent idea of the working of the system. At present the risks of these insurance companies include cotton and woolen mills, all textile mills, rubber manufactories, metal factories, foundries, paper mills and everything included in the large manufacturing industries of New England and the Middle States. They have not gone very largely into the Western and Southern States until within the past few years. Their experience is that they are giving insurance to the amount of something over $500,000,000 to-day, at a cost of less than one-fifth of one per cent. per annum. Their average rate is about one per cent. Their lowest rate is about eight-tenths of one per cent., and they vary from that upwards, according to the risks, so that it brings their average rate on the $500,000,000 to about one per cent. They have returned in dividends, after paying all losses, all expenses and everything pertaining to the conduct of the business, on an average more than 67 per cent. You will bear in mind that this average includes their operations since they were first organized, when the construction of factories was very inferior and before the introduction of modern fire appliances. At the present time the lowest dividend paid by any one of those companies is 60 per cent., the highest 95 per cent., the average being about 85 per cent.

Thus we have this valuable experience as a basis to guide us, and I do not think that we are wrong in assuming that an electric light station as it is constructed to-day, with all the safeguards and the same adequate amount of fire appliances in the way of protection, constitutes just as good a risk (and in most cases, a far superior one) as those that the manufacturers' mutuals have made their showing upon. That is the only uncertainty, if indeed it may be called an uncertainty, that we have to deal with. Such being the case, I can see no reason why we cannot show just as good results as they have done, and in time when our business shall have assumed proportions so that our expense ratio will be reduced, we are in hopes that we shall show better results than they have done. Their whole expense ratio including all expenses of conducting the business, traveling, inspections, office incidental expenses, and everything, is on the average about eight per cent. of their premiums, as compared with the system of stock insurance, when 30 per cent. of every dollar they take goes in the way of commissions to general agents and subordinate agents. That 30 per cent. covers with the mutual system not only the expenses but all the losses in their business.

As I stated to you, there are no agents employed with the manufacturers' mutuals or the Electric Mutual, consequently it has never been deemed desirable, by the manufacturers' mutuals, to comply with the laws of the various States, that is, by getting regular legal admission to the different States. The laws in most all the States are different. Some of them were enacted absolutely and solely in the interests of stock companies, for the purpose of keeping out all competitors, and there are many unfair, and I might say unconstitutional, laws which have been enacted with this end in view. The only thing that we could gain, if it might be called a gain, by complying with the laws of any state (take Minnesota for instance), would be that a policy holder in Minnesota suffering a loss in the Electric Mutual could bring suit against the company in his State.

Two or three of the companies have complied with the laws of two States, namely, Ohio and Illinois, because they have been doing considerable business in those States during the past few years.

Having thus entered the State, they have an agent of their own right on the ground who can be reached in case of any need without delay, and this is certainly a desirable arrangement.

You will doubtless often hear it stated that the Electric Mutual Company is an unsafe company to insure in because of the fact that it is not admitted to your own particular State, and that if you want to sue it you must go to Boston to get at its property. If it were not for the fact that this is a company in which you are interested yourselves, in fact, a company which you control, there might be some weight in such a statement; and as to its location in your own State, considering the foregoing facts, I do not think any of you will regard that as a very important matter. This whole question, however, will come up before our directors at the next meeting, and I have no doubt but what we shall decide to make an entrance into Ohio and Illinois, possibly Michigan, and may be some other States.

In many of the States the laws are such that it makes it a misdemeanor for any representative or inspector to in any way negotiate or transact insurance business in that State without having entered it legally, and upon arrest will subject the person to a fine. In two States, New York and Pennsylvania, the laws, passed deliberately in the interest of stock companies, make it a misdemeanor on the part of the representative of the insurance companies, and also of the assured who accepts the policy, and if there ever was a piece of unconstitutional law, I hold that is the most positive example of it. Take it in the case of an electric light station; it has been found to be almost impossible to secure insurance in companies admitted to the State. In such places the law says that the assured has no right, without liability to fine, and perhaps imprisonment, to undertake to protect himself by securing insurance outside of the State. As a matter of fact there has never been a decision on those laws. In the State of Pennsylvania, however, some little time ago, one of the directors of the Keystone Manufacturers' Mutual, of Philadelphia (one of the manufacturers' mutuals), openly secured insurance in the New England mutuals for the purpose of testing the case. He was arrested and fined, but the case has been carried to a higher court, and I do not know that that court has yet rendered a decision. Some few policy holders in Pennsylvania, not wishing to assume any chances of being annoyed, "have beat the devil around the stump," or evaded the law, by appointing an agent outside of the State to procure the business for them. They transact their business through that agent. Their money is deposited in a bank outside their State, subject to the agent's draft, but ostensibly for no particular purpose, and therefore the whole transaction is covered up and they are not amenable to the law, because there is no proof of their having violated it.

I thought it well to explain these matters to you now, which are, no doubt, new to some of you, in order that you may know the facts and act accordingly.

I do not know but what I have covered the ground pretty thoroughly, and may, perhaps, have taken too much of your time. I should be glad, however, if there are any points which you do not understand, to answer any questions and make any further explanations necessary.

Mr. POST: What is your rate of premium?

Mr. BARTON: Nine-tenths of one per cent. is our minimum rate. Our rates have averaged a little over one per cent. up to the present time. Of course this rate of nine-tenths applies to a station of the best construction, built of brick or stone, not over two stories high, having the electrical apparatus arranged in strict accordance with the requirements, and all necessary fire appliances. This building must be free from any wooden construction inside, such as sheathing or anything of that sort. It need not, however, be necessarily a fireproof station. It shall not have any exposures, but if there are any, the same must be cut off by fire shutters on all openings. The station shall have what we term a "standard of fire protection," with pumps, and hose attached. The hose shall be small or large, according to the size of the station, but preferably small, the idea being that any part of the station can be reached instantly with a small stream. In connection with this hose there must be constant water pressure, which means that the supply of water shall always be on hand without having to start a pump. In case this pressure cannot be secured, fire extinguishers must be provided. In case the station is exposed the exposure charge must be specially made according to the conditions.

Our desire is to issue policies in every instance in blanket form, that is, covering the building and its contents, without specific divisions. I have here one of the forms. It covers in this way the main building and projections, if any, which constitute a single station or risk, and all the contents thereof, consisting of boilers, steam engines, shafting and belting.

Mr. SMITH: Do you make any reduction for water power?

Mr. BARTON: We find no particular difference for the reason that generally speaking water power stations are farther removed from the fire department than the steam power, in which case matters are neutralized.

There is another insurance that we have considered, and that is the insuring of the plant outside the station. Up to the present time we have issued about one dozen of such policies. We have given blank policies covering every article of property connected with all the outside circuits, against loss or damage by fire, including everything connected with the circuit from the time it leaves the station until it returns. Wires, poles, lamps, converters, meters, fixtures, etc.; on this class of insurance we have fixed the rate at ¼ of 1 per cent., and at the end of the year we will be in a position to judge whether this is an equitable rate. It is a class of insurance in which we are liable to a great many risks, but I believe should be taken care of by our company.

A word as to our directors; as they are now constituted I am sure you will recognize them. Mr. F. A. Gilbert, president of the Boston Electric Light Company, who started this idea in 1884 at the Baltimore convention of the National Electric Light Association. He sent out at that time to such of the electrical companies as he could obtain the addresses of, a circular asking their opinion as to the formation of a mutual company. From 100 inquiries sent out he received 30 responses, all but two of which were favorable to the scheme. Nothing however could be done, as the Massachusetts law requires that 200 separate risks shall be pledged.

Mr. C. L. Edgar, manager of the Boston Edison Company, and E. W. Burdett, counsel for the Boston Electric Company, and also for the Electric Mutual Company, and vice-president of the same; General Benjamin F. Peach, Thomson-Houston Company; T. C. Bates, director Worcester Electric Light Company; Robert B. Taber, at that time of the New Bedford Gas Light Company; Elisha Morgan, president of the Springfield United Electric Company; Thomas T. Robinson, Thomson-Houston Electric Company.

These, with Captain Brophy and myself, were the original 10 directors. Under the law of Massachusetts, the incorporators had to be residents of the State. At a special meeting, called shortly after the organization, there were added Mr. Hastings, of the Edison Company; Mr. Perry, of Providence; A. M. Young, of Waterbury, Conn.; Mr. John I. Beggs, and one place was left vacant for a representative of the Westinghouse Company. The Westinghouse Company had nominated a gentleman who failed to qualify by becoming a policy holder in the company. Of course the by-laws require that any person to be a director of the company must be a policy holder.

The PRESIDENT: I know that I express the sentiment of the association when I say we appreciate very highly the clear exposition of the Electric Mutual Insurance Company which Mr. Barton has given us. I desire to add to what Mr. Barton has said, having been for several years in the insurance business myself, both in the capacity of large local agent and as a special agent and adjuster for several companies throughout Pennsylvania, that I have given this matter a great deal of careful attention, and I therefore give to this insurance company my unqualified approval. I recommend it to your most favorable consideration. As you see, Mr. Barton's business energy and the able assistance of Captain Brophy, the inspector of this company, have now put it upon its feet so that it will be sure to stand whether you help it or not. Therefore, it is for your interest that I say that I give it my unqualified approval. It is for your pecuniary benefit. Stock companies have been squeezing us for about three years, and it is about time now that we secure fair treatment.

As an illustration of the methods that have prevailed in the past I will cite the case of a Harrisburg company. I fixed that rate at one per cent. some years ago. It was a fair rate both to the companies carrying it and to the Harrisburg company. After I surrendered control, the agents thought they could secure more by increasing the rates and they run the risks up to $2.60 on the hundred. I took the position that I would not be swindled and I insisted upon the Harrisburg company dropping the insurance, making arrangements in New York by which I had the risk carried at the rate of one per cent. Being one of the directors of this company, I can simply say that I believe the Edison interests are amply protected in the Board. You have Mr. Edgar, Mr. Hastings, treasurer of the General Electric Company and myself largely interested in the welfare of the Edison interests generally, and I am very desirous, indeed, of seeing all the aid possible given to this company. Besides the insurance feature of it, to some of you who have no insurance whatever I would say particularly that the value of Captain Brophy's inspection of your stations to put you in the position of not being burned out is worth all that the premiums cost you if you have no policy for it. That may seem a broad statement, but I make it as an investor in the electric light interests, and as such I would pay Captain Brophy the amount of the premium in behalf of the Harrisburg company for his services.

You must remember that one of the most important elements in considering the fire hazard is the question of prevention, and it is far better that you should place your station as far from hazard as possible rather than look for low rates of premium, and an adjustment in case of loss, for the reason that whatever we may receive from insurance can never compensate us for the loss sustained in the suspension of business and the inconvenience we are subjected to.

Mr. BALKAM, of Brockton, Mass., submitted the following resolution:

Resolved, That the Association of Edison Illuminating Companies in convention assembled hereby tender a hearty vote of thanks to Mr. S. E. Barton for his able exposition of the mutual insurance question and the aim and objects of this company; and the Association, recognizing the many advantages of such a system of insurance, hereby gives its unqualified support of the Electric Mutual Insurance Company: and

Resolved, That the report of the special committee comprising the informal statement of the secretary, and the supplementary statement of the results of their work as detailed by Mr. Barton, be received and spread upon the minutes of the Association, and that the committee be discharged with the cordial thanks of the Association for their conscientious work during the two years of their successful service.

Mr. Markle, Detroit, as chairman of the Committee on Fuel Gas, made a brief report as to the progress made since the Niagara Falls convention in the experimental work of adapting this fuel to uses akin to that of electric light and power stations.

Mr. F. E. JACKSON, of the lamp department of the Edison General Electric Company, presented the following paper on

SOME SPECIAL LAMPS MADE AT THE EDISON LAMP WORKS.

It is desired to call the attention of the managers of the illuminating companies and others to a few lamps provided by the lamp works which are designed for special uses. With the exception of the small battery lamps the lamps to be described have not been long on the market, and are but little known.

The small low-volt lamps which are made for use with primary batteries have been manufactured for several years, and are more or less known to all, although comparatively few have been used in central stations; until recently comparatively few have been made, but now the demand is increasing rapidly. The one purpose for which these lamps were made was, as their names indicate, for use with batteries, and particularly with primary batteries. The E. M. F. of the lamps is very low, varying from 10 to 12 volts in the six c. p. lamps to as low as two and a half volts in the small half c. p. lamp made for the use of surgeons and dentists. The E. M. F. is purposely made low so that the lamps can be used with the least number of cells of batteries. It should be noted that not less than two cells can be used with any of the lamps.

The lamps vary in candle power from one-half to six candles. They are also made of ¼ c. p. in the special forms of "dental," "surgical" and "pea" lamps. The efficiencies are high, as they should be where current is as costly as it is where primary batteries are the generators; the efficiencies average not more than two volts per candle.

It was stated that not many of these lamps had been used until within a short time. The reason, no doubt, is that they were not advertised in a way that would bring them to the notice of possible purchasers. A small pamphlet de-

scriptive of the lamps and of cheap batteries that can be used with them is now issued by the lamp works, and the lamps have lately been advertised more extensively in other ways. The results are easily seen in the number of lamps ordered. Also there have been so many orders received for material for making the batteries described in the catalogue that it was decided to make up complete outfits, and these are now made and kept in stock. By securing a few samples and advertising them, the illuminating companies would find a sale for a good many lamps.

About a year ago there was a demand for small lamps suited for burning in series on the regular 110 volt lighting circuit. Before the time mentioned there had been no special demand for lamps to be burned in series, and no lamps had been made for that purpose. The "battery" lamps were used in this way in a number of cases, but they did not always give satisfaction. It was found that to give the best results when used in this way, the carbons in the lamps should be made of different proportions and different dimensions. The lamps then made for burning in series on the dynamo circuit have given very satisfactory results. They are the lamps which were used in the electrical exhibition at the Lenox Lyceum, New York, last winter, and which are used here at the Minneapolis Exposition, where they speak for themselves.

The "small series burning lamps" are made higher in voltage and of lower efficiency than the battery lamps. They are made of candle powers one to four candles. The voltage of all lamps is about 14 volts, so eight lamps of any one candle power can be burned in series on the 112-volt circuit. The lamps are made of efficiencies varying in different lamps from three to five watts per candle. The lamps are tested and marked for the current taken when burning at normal candle power, and those taking the same amount of current are selected for burning in series togther. The "series burning lamps" are made of lower efficiency than the battery lamps. When a dynamo is used as the generator the cost of producing current is low as compared with the cost of the current from a primary battery; therefore high efficiency is not so great an object; also as the lamps are burned in series, the breaking of one lamp stops the flow of current in several others, making it appear as though the lamps broke more frequently than they actually do. The comparatively low efficiency of the series lamp is an advantage as the increased lamp life which comes with a decrease in efficiency reduces the number of renewals proportionally, and also prevents the annoyance which would be the result if the lamps broke more frequently.

Some tests in order to determine the best efficiency to give these "series burning lamps" are now being made at the lamp factory. So far the results are very satisfactory. At the time of this writing only one lamp has broken, and that at the end of 320 hours. The number of lamps burned in the test was 22. Another set of 33 lamps has been burning for 250 hours and no lamps have been broken.

The lamp which, it is believed, will become the most popular one for decorative purposes and for producing science effects has not yet been used outside of the factory, the lamps having been made only during the past few weeks. The lamp referred to is the one c. p., 14 volt, or "eight-inch series" lamp. For use in fancy designs and in producing effects where it is the effect only and not illumination that is wanted, the result obtained with the one c. p. lamps are quite as good as those obtained with the lamps of higher power. The decided advantages in using the one c. p. lamps are that less current is required than for the three and four c. p. lamps, and the heating effects are less also.

In the exhibition we have an illustration of some of the uses to which these small lamps can be put, but there are many ways in which they can be used with profit on a smaller scale by the illuminating companies. A profit can be derived from the sale of current to light them. At the lamp works several different fancy designs have been gotten up when called for, in which the small lamps are arranged in the form of letters spelling words and names. The lamps have also been arranged in other forms, such as stars. With suitable switches the lamps forming letters, words or different parts of designs can be lighted or turned off at will, attracting the eye and producing pleasing effects. We think that there is a sale for a large number of such signs and figures for use in stores, large and small, and in hotels, etc.

The lamps are made of different colors. The colors in which they are now made are red, blue, violet, green and amber. These colored lamps have been made only during the past few weeks, and they have been used only to a limited extent as yet. It is hardly necessary to say that with the colored lamps the number of combinations and effects that can be produced is greatly multiplied. The handling of these small lamps is a branch of the electric lighting business which has not yet been taken hold of and developed by the illuminating companies; it is believed that when the lamps are better known they will find a large demand.

Another lamp to which it is desired to call attention is the lamp specially designed for use on power circuits where lamps are burned in series, and particularly for use on the 500-volt street railway circuit; in fact, the lamp is called the "electric railway lamp," and it is so labeled. When the electric railway business was first started it was intended, of course, to use incandescent lamps, but the question of the proper lamp to use was of small importance in comparison with others, and it was neglected in consequence. The lamp generally used on the Sprague roads when they first started was the regular 100-volt 16 c. p. lamp, the lamp of highest resistance and highest efficiency.

The importance of selecting lamps taking the same current when they are to be burned in series was not considered, and very often, I think I may say that on almost every road, lamps of different sizes and of different manufacturers have been placed in the same series, with results not always explained or accounted for, but apparently unfavorable, by comparison, to the lamp taking the least current under normal conditions. If a lamp of higher candle power, or if any lamp of equal voltage and taking a greater current, is burned in series with a high efficiency 16 c. p. lamp, the result is that the 16 c. p. lamp receives the greater pressure; and, if the pressure is normal for burning two similar lamps in series, the 16 c. p. lamp would be forced above normal candle power, and would soon be broken, if not broken immediately.

The Edison lamp has been the lamp of highest resistance on the market, and therefore it has been the one to suffer most for the above reason. As before stated, the Sprague roads have generally used these lamps at starting. No special lamp was made for the use of the railway companies, and no particular lamp has, in most cases, been recommended, consequently all lamps have been considered as being alike and suited for burning in series, particularly if they had the same marks for voltage. The natural result has been that dissimilar lamps have been placed in the same series, and the 16 c. p. Edison lamps have often given a very short life when, if they had been used alone, they would have given the best results. For the reason that the causes mentioned have not been understood, a large part of the lamp renewal business has been lost to the lamp works and to the illuminating companies.

The difficulty has been recognized by the lamp works, and we believe that it has been effectually provided against in the "electric railway lamp," which has but lately been put on the market.

These "electric railway lamps" are designed particularly for the use of railways, but they are equally well suited for use on other power circuits, or in all other cases where lamps are burned in series on circuits of 200 to 500 or 600 volts. The lamps are made to give 16 c. p, the voltage ranges from 95 to 100 volts, and they take currents varying in different lamps from .60 to .75 ampère. The lamps have a special label, and the normal currents, the fractions of an ampère required to bring the lamps to 16 c. p., are marked on the labels.

The lamps are selected for voltages ranging from 95 to 100 volts, but the voltage is not marked on the lamps. The marks for voltage have been found to produce confusion; customers, in some cases at least, have supposed that all lamps having the same marks for voltage were suited for burning in series as well as for burning in parallel circuit, whether the lamps were of the same resistance or not. For this reason the marks for the voltage of the lamps are omitted altogether.

As the regular 16 c. p. lamp has a very fine and delicate carbon, it was thought best, in designing the "railway" lamp, to give it a stouter carbon such as would not be so easily injured by the mechanical strain to which the carbons of the lamps are subjected. Also very high efficiency is not to be desired in these lamps on account of the constant variation in the E. M. F. on the circuit. The efficiency of the lamp as determined on is about four watts per candle. Lamps of this efficiency will give the best results. The voltage on the circuit can fall considerably below the 500-volt limit, as it is constantly doing on the railway circuits, without bringing the lamps to a very low incandescence; also an increase in pressure of 10 per cent. will not cause the lamps to break at an abnormal rate.

Although the lamps in the regular stock will vary so as to take currents varying in different lamps from .60 to .75 ampère, it is not supposed that the lamps taking this whole range shall be sent to any one place. For any one plant the range of currents taken by the lamps will be limited to about $\frac{1}{100}$ ampère, or all lamps sent to any one plant will be practically identical.

At the lamp works, and at other places where the "railway" lamps will be kept in stock, records of the ampèreage or the currents taken by the lamps sent to the different plants will be kept, so that it will always be known just what lamps are wanted when lamps are called for by the railway company's renewal orders, and lamps of the same resistance will always be sent for use on the same circuits. Therefore it will be necessary to specify only the "electric railway lamp" when ordering lamps, and the proper lamps will be selected at the lamp works or at the other storehouses where the lamps are kept.

Electric railways are being introduced very generally now, and such a large number of lamps are being consumed by them that it is well worth the while of those interested to look after the lamp renewals and see that the best lamp is used. Where there are different roads in the same town, or where there are several different branches of the same system, it would be an advantage to have signal lamps of different colors on the different cars to distinguish those on one branch from those of another. Such colored lamps will be provided by the lamp works at small additional cost; we can now provide them of five different colors; when colored lamps are ordered by the railway companies the lamps will be selected for the currents taken in the same way that the plain lamps are selected, so that all will be suited for burning in the same series. On the street cars colored lamps can be placed on the front and rear platforms and in conspicuous positions to serve as signal lamps, while the remaining three lamps in the series are used to illuminate the interiors of the cars.

It may be added that the lamps will be made with bases other than the Edison bases; but, unless some other base or plug is specified, all lamps will be made to fit the regular Edison socket.

Mr. L. Stieringer, the well known expert in the diffusion of light, being called upon to make some further explanations of the possibilities in the application of small lamps, gave an interesting and valuable informal talk upon the general subject, referring among other things to the effects produced by the Tower of Light at the Minneapolis Industrial Exposition.

Mr. E. R. Weeks, of Kansas City, introduced the subject of the heating of buildings from central stations by exhaust steam, and a discussion which followed brought up Messrs. Edgar, Beggs, Markle, and Vail.

Appurtenant to the subject of insurance, the secretary read the following paper, signed by W. J. Jenks, upon the formulation of a code of insurance rules which it is proposed shall be adopted by the underwriters throughout the country:

A NATIONAL CODE OF INSURANCE RULES AFFECTING ELECTRIC AND POWER INSTALLATION.

It has often been noted as one of the evidences of the incomplete development of the present system of electric light and power construction that the rules enforced by the underwriters in different sections of the country are so widely different as to make it impossible for a construction firm in Boston to be at all certain of being able, without further education, to do work in Philadelphia acceptable to the insurance inspector, or for a supply man in Chicago to be sure that he is furnishing material which the underwriters of Cincinnati will approve.

From the time of the formation of the original rules for wiring of buildings for incandescent lamps (resulting from the conferences of the New York Board with the practical people of the Edison Company) to the present, all codes used by the insurance fraternity have, while annually growing nearer to a standard, embodied so many uncertain quantities and individual notions that it has been hard to predict what a year might bring forth in modification of existing requirements. Very much has been done by the earnest efforts of the inspectors of the New England Exchange, and the New York State Board, as well as by the practical labors of the Philadelphia Fire Patrol and the Chicago city officials, but it has been reserved for the present year to evolve a plan which promises to speedily revolutionize the chaotic condition of matters of this kind by harmonizing all the minor distinctions which exist in the codes heretofore enforced by the insurance inspectors of different sections in one national code, which, by reason of the authority by which it is supported, will be adopted by a large majority, if not by the entire fraternity of the insurance men in the United States.

At the Kansas City meeting of February last, the National Electric Light Association chose a committee for the purpose of conferring with the insurance people, and, if possible, of setting on foot such measures as might result in this uniform code.

Pursuant to this plan the Secretary of the Committee, Mr. George Cutter, of Chicago, entered into correspondence with the representatives of the active executive insurance associations, and with the leading electric light companies of the country, and the result of his persistent and intelligent endeavors in this direction appeared at a meeting of the committee and the representatives of the two interests which convened at the Stockton Hotel, Cape May, Aug. 16, three days in advance of the first session of the convention of the National Association.

The Committee held its first meeting on Saturday evening, Mr. Cutter in the chair, and the names of the remaining gentlemen present were as follows: C. M. Goddard, Inspector New England Insurance Exchange, Boston, Mass.; E. C. North, Chairman Electric Light Committee, New England Insurance Exchange; S. E. Barton, President of the Electric Mutual Insurance Company, Boston; Wm. Brophy, Chief Inspector Electric Mutual Insurance Company, Boston, and representatives of the Mutual Fire Insurance Companies of New England; F. E. Cabot, Inspector Boston Fire Underwriters' Union; W. H. McDevitt, Inspector Philadelphia Fire Underwriters' Association; J. P. Barrett, City Electrician, Chicago, Ill., and also representatives of the Chicago Board of Fire Underwriters; W. A. Anderson, Secretary New York Board of Fire Underwriters, and also Secretary of the National Board of Fire Underwriters; W. De L. Boughton, Chairman Electric Light Committee, New York Board of Fire Underwriters; H. O. Kline, Chairman of the Electric Light Committee Underwriters' Association of the Middle Department, Philadelphia, Pa.; J. J. Babcock, Chairman Light Committee Insurance Association of the State of New York, Binghamton, N. Y.; C. E. Bliven, Chairman Electric Light Committee, Western Union Fire Underwriters' Association, Chicago, Ill., and representative of the Fire Underwriters' Association of the Northwest; J. S. Alfred, Inspector Southern Tariff Association, Atlanta, Ga.; R. H. McMath, Representative St. Louis Board of Fire Underwriters; J. R. Lovejoy, Thomson-Houston Electric Company, Boston, Mass.; P. H. Alexander, Westinghouse Electric Company, New York; W. J. Jenks, Edison General Electric Company, New York.

Mr. Cutter was chosen secretary, and the chairman stated the object of the meeting as being the securing of a harmony of ideas between the electric light and insurance interests.

An extended discussion of the proper basis of a code of generic or fundamental rules extended through several sessions, and resulted in an outline representing practically the unanimous views of the gentlemen present. Exhaustive statements of the reasons for the positions assumed in this initial code were made by the electric light representatives and agreed to by the insurance inspectors as embodying the results of their experience. A special committee presented at the second session a code of by-laws as the basis of a permanent organization, which was, early in the deliberations of the meeting, decided upon as the only practical method of securing and perpetuating an influence sufficiently positive and controlling to be permanent. A concise summary of a few of these by-laws will illustrate the scope of the work to be done, the solidity of the basis upon which the organization was effected, and the standing of the insurance representatives composing the organization is a guarantee of that important work in that executive direction in which former efforts have been lacking.

The name decided upon was "The National Electric Insurance Bureau," and the object is stated by the by-laws to be "the harmonizing of the electric interests and the fire interests in the United States."

It is also provided that in addition to the membership indicated by the names of those in attendance, one member may be chosen by the National Telephone Association, one by the Western Union Telegraph Company, one by the Postal Telegraph Company, one by the National Association of Fire Engineers, one by the Underwriters' Association of the Pacific Union States, and such other insurance representatives as may apply for membership and be deemed eligible.

It was settled that as a method of completing an organization for the opening year the gentlemen of the committee chosen by the National Association and the representatives of the other organizations aboved named having been called together by the original committee should be members of the Bureau until the next meeting, or until their successors were chosen.

Officers were elected as follows: President, Major C. E. Bliven, Chicago; Secretary and Treasurer, George Cutter, Chicago; Executive Committee, Messrs. Bliven, Brophy, Lovejoy, Jenks, Anderson, McDevitt and Cutter.

A committee consisting of Messrs. Barrett, Goddard and McMath was chosen to gather information regarding city and state laws bearing upon electric interests.

After a very careful discussion of the best method of attaining the primal object of the meeting, namely, a uniform code of rules which shall be national in their application, the following members were chosen a committee to outline such a code: Messrs. Bliven, Cutter, McDevitt, Cabot and Jenks.

The deliberations of the meeting consumed six sessions, and an adjournment was made on Monday evening, Aug. 18, subject to the call of the president, or to the time of the annual meeting, which, by the by-laws, was fixed to be held some time during August of each year at such day and place as the Executive Committee may determine.

The committee charged with the work of codifying rules were instructed to secure as many different sets of codes as may be at present in force by any of the State or local boards throughout the country, and by such light and power companies as may have given careful thought to this matter. It is proposed that these shall be, if possible, harmonized and condensed, and that a draft embodying whatever may be desirable from all be sent by the committee to the organizations from which the different codes emanated for criticism and suggestion. Also, that on return of such criticisms a final arrangement may be made,

and an improved code, thus prepared, submitted to a future meeting of the Bureau for adoption.

It will at once be seen that from the fact that the large majority of the members of this Bureau are executive insurance officers, and that as they represent one hundred and fifty or more of the leading insurance companies doing business throughout the United States, the adoption of any code of rules by such a body will mean its immediate enforcement throughout the territory over which they have control. Copies will at once be sent to the representatives of these numerous companies, including contract agents and local boards, and the inspectors will be provided with the code as a method of instruction, simply forming an addition to their previous duty, for the general inspection of buildings, and thus a most effective plan of determining whether or not proper methods have been pursued will at once be adopted by the underwriters. Hence, by the operation of a logical and mandatory plan a rigid surveillance will be exercised over all constructing firms, and a great advantage immediately gained by the application of a uniform standard throughout the country.

The significance of the action taken and the probable results may be better understood when it is remembered that this is the first systematic effort made to secure the adoption of a uniform code of rules by the executive managers of a large number of the different insurance organizations represented by the several associations of the United States.

Mr. CARROLL, of Birmingham, Ala., then offered the following, which was unanimously adopted:

Resolved, That the Association, recognizing the great importance of securing uniformity in the insurance rules by which installations of electric light and power throughout the United States are inspected, express their interest in the work of the National Electric Insurance Bureau, as reported by our secretary, and bespeak for the codifying committee of the Bureau the cordial co-operation of all electric illuminating companies which may be able to contribute to the result which the committee has in view.

The Executive Committee presented the following resolution, which was unanimously adopted:

Resolved, That the president and secretary of this Association be requested to express to the committee on the census of the United States Senate the hearty approval and support of the Association of Edison Illuminating Companies of Senate Bill entitled "A Bill to Amend an Act, Entitled An Act to Provide for the Taking of the Eleventh and Subsequent Census," approved March 1, 1889; and further, that the members of this Association be requested to urge upon their respective representatives in Congress the necessity for the passage of said bill.

Mr. Van Sickel, of Sault Ste. Marie, inquired as to the proper construction of submarine cables for electric light and power works, and remarks were made by Messrs. Stieringer, Edgar, Beggs and Nichols, and the secretary was instructed to request Mr. Kennelly, of the Edison Laboratory, to prepare a paper on the subject to be incorporated in the minutes of this meeting.

On motion of Mr. Edgar the Association adjourned to meet on the Atlantic seaboard 12 months hence, the exact date and place to be designated by the Executive Committee.

The members present at the opening session were as follows:

EDISON GENERAL ELECTRIC COMPANY.—Samuel Insull, second vice-president; H. Ward Leonard, general manager Light and Power Department; John Muir, general manager Railway Department; Francis R. Upton, general manager Lamp Manufacturing Department; F. E Jackson, inspector Lamp Manufacturing Department; Wilson S. Howell, inspector Lamp Manufacturing Department; W. J. Jenks, Legal Department; H. J. Sullivan, official stenographer; L. Stieringer.

ILLUMINATING COMPANIES.—John I. Beggs, director Harrisburg R. L. Co., Harrisburg, Pa.; Geo. H. Finn, secretary and treasurer Edison Co., St. Paul, Minn.; C. H. Maxey, secretary Edison L. & P. Co., Minneapolis, Minn.; Oscar Ericsson, superintendent The Cascade Milling Co., Sioux Falls, S. D.; Edwin R. Weeks, general manager F. E. L. & P. Co., Kansas City, Mo.; Frederick Nicholl, manager and secretary Toronto Incandescent E. L. Co., Toronto, Can.; F. G. Kurz, superintendent Appleton E. L. Co., Appleton, Wis.; B. L. Smith, assistant secretary and superintendent, Laramie E. Gas Light & Fuel Co., Laramie, Wyoming; Wm. D. Kurz, superintendent E. L. & P. Co., La Crosse, Wis.; Wm. L. Church, superintendent The Chicago Edison Co., Chicago, Ill.; John R. Markle, director E. L. and Fuel Gas. Co., Grand Rapids, Mich.; M. A. Beal secretary and treasurer Forest City E. L and P. Co.; W. M. Van Sickel, manager Edison Sault L. and P. Co., Sault Ste. Marie; W. F. Wollin, superintendent E. E. L. Co., York, Pa.; Leigh Carroll, president E. E. I. Co., Birmingham, Ala.; C. L. Edgar, general manager E. E. I. Co., of Boston, Mass; J. A. Colby, secretary and manager Des Moines Edison Light Co.; W. S. Barstow, assistant superintendent E. E. I. Co., Brooklyn, N. Y.; J. Smith, general operating superintendent E. E. I. Co., New York; Chr. Wuestenfeld, manager Elgin City Railway Co., Elgin, Ill.; A. L. Smith, president Appleton Edison L. Co., Appleton, Wis.: C. P. Gilbert, secretary and manager E. L. Co., Detroit, Mich.; Hoyt Post, director and attorney E. E. L. Co., Detroit, Mich. Choice of officers for the ensuing year resulted as follows: President, John I. Beggs; vice-president, C. L. Edgar; secretary, W. J. Jenks: treasurer, Wilson S. Howell. Executive Committee, John I. Beggs, ex-officio; A. L. Smith, Appleton, Wis.; Thomas P. Merritt, Reading, Pa.; E. R. Weeks, Kansas City, Mo.; C. P. Gilbert, Detroit, Mich.; Leigh Carroll, Birmingham, Ala.

The following gentlemen were also in attendance at the sessions of the convention: Fred De Land, E. L. Powers, D. B. Dean, W. F. Collins, J. B. O'Hara, A. C. Duborow, of Chicago; T. R. Taltavall, R. B. Corey, E. T. Greenfield, H. L. Lufkin, J. F. Kelly, Robert Coleman, of New York; Stephen E. Barton, of Boston; A. D. Newton, of Windsor, Conn.; V. Hinrichs, president, and F. W. Krause, secretary, Carroll E. L. and P. Co., Carroll, Iowa; Arthur S. Huey, Clift Wise, and Thomas Lowry, of Minneapolis.

CONVENTION NOTES.

Thursday afternoon a visit was made to the Edison station in St. Paul, under the guidance of Mr. George Finn, and other points of interest were also visited.

Mr. Clift Wise, the well-known street railway engineer, left for New York on Wednesday evening, rumor says to accept a very responsible position in the metropolis.

Thursday morning Colonel Thomas Lowry gave the visitors a ride over his lines, and the entire equipment was carefully inspected under the guidance of Mr. Forée Bain.

Mr. Charles Wilson, the Northwestern representative of the Babcock & Wilcox Company, talked "steam" in his usual fluent manner, and looked after the general interests of the delegates.

Mr. M. J. Sullivan, of New York, the official stenographer of the Edison Association, won the hearts of the entire newspaper fraternity by his courteous attention to their requests for copy.

The Hart & Hegeman Manufacturing Company, Kansas City, Mo., distributed a neat little folder, containing the description of the Hart snap switch, illustrated and described in THE ELECTRICAL WORLD of Sept. 13, 1890. Mr. Baird looked after the company's interests.

The visitors were shown through the large station of the Minnesota Brush Electric Company by Mr. A. M. Robertson, the general manager, and Mr. J. T. Boustead, the superintendent. About 1,200 arc lights and some 8,000 incandescent lamps are being operated from this station, as well as 50 motors.

Mr. Eugene Tucker, of the Edward P. Allis Company, Milwaukee, had the pleasure of starting the big 1,000 h. p. triple expansion Reynolds Corliss engine in the power house of the street railway company on Wednesday last, and then left that evening for Pittsburgh, Pa., where work of a similar character is awaiting his arrival.

Carriage and horseback rides were enjoyed in Minneapolis, and the important isolated plants in the Guaranty Loan Building and other important office structures were all visited, as well as the new Edison station, and the excellent work done therein fully commented on, Mr. Arthur G. Huey, the local agent of the Edison General Company, sparing no efforts to entertain the visitors.

On arrival of the delegates in Chicago they were given every opportunity to thoroughly investigate all the details in the big Edison station and the projected sub-station. Other points of interest were also visited, notably the Auditorium, where 12,000 Edison lamps are in service, and at 5:30 P. M. the party left for Minneapolis in their special car over the lines of the Wisconsin Central Railway, arriving at the West Hotel at 9 o'clock Tuesday morning.

Mr. F. W. Cushing, the genial secretary of the Central Electric Company, Chicago, was given a cordial welcome by the delegates at the West Hotel on his arrival, Wednesday afternoon. In referring to matters of business, Mr. Cushing said the orders now pouring in were greater in number and in the amount of goods called for than at any one time before, and clearly indicated that an unusually heavy business in supplies would be transacted this fall and winter.

Mr. Forée Bain, the well-known electrical engineer of Chicago, accompanied by Mrs. Bain, is stopping at the West Hotel. Mr. Bain is the consulting electrician of Colonel Lowry's street railway interest, and in making a careful test of the underground conduits laid down by the Interior Conduit and Insulation Company, he found that although an unusually heavy storm of rain, lasting for several hours, had filled the manholes and ducts with water (the manholes not having been sealed, owing to a lack of time before the storm came on), yet on pumping out the greater portion of the water the car service was continued uninterruptedly, and a test taken at 1 P. M. showed the insulation resistance of the ducts to be above five megohms. The conductors are bare stranded cables. When the work on the manholes is completed there will be no opportunity for moisture to creep in, and, being double jacketed, no leakage can occur.

Board of Electrical Control.

At a meeting of the Board of Electrical Control on the 19th inst., Dr. Wheeler, the electrical expert of the Board, presented his report on the death of lineman Kopp. The report entirely exonerated the United States Company, the employers of the unfortunate lineman, from blame, and showed that his death was caused by his own gross and inexplicable carelessness in disregarding the regulations of the company, which enjoin the use of rubber gloves on all occasions when the handling of the wires is attended with risk.

The Mayor would not accept the report. He thought that the United States Company should not have had any current whatever on while repairs to the lines were in progress. He also wanted to know more about the grounding of wires, and to have some more definite recommendations as to the prevention of such accidents in future. When asked by Dr. Wheeling whether he proposed to advance some new principles in accordance with theories of his own on the subject of "grounds," the Mayor replied that his intention was to see that everything that could possibly contribute to the safety of human life should be done. The amended report will be considered at the next meeting of the Board. Dr. Wheeler's report on the injuries received by Charles B. Young at Pearl street and Maiden Lane was accepted. From the official investigation it appears that the lad was struck by a dead telegraph wire which was caught by a passing train. The wire twisted around his body and lifted him several feet in the air. He was thrown to the pavement, stunned by the fall, but with no marks of burning upon him.

Colonel Kearney, the engineer of the Board, presented his report on the charges made by several electric lighting companies in regard to the rentals charged by the Consolidated Telegraph and Electrical Subway Company. Some time ago, owing to the dissatisfaction that existed, this matter was referred to Colonel Kearney for investigation. The dissatisfied companies were the East River, the Brush Electric Illuminating, the United States, the United Electric Light and Power, the Manhattan Electric Light, and the Harlem Lighting Company. These corporations complained of the excessive rates of the Subway Company, which were as follows: For 4-inch ducts, $1,250 per mile per annum; for 3-inch ducts, $1,000 per mile per annum; for 2½-inch ducts, $850 per mile per annum; for 2-inch ducts, $700 per mile per annum; for 1½-inch ducts, $550 per mile per annum; for 1¼-inch ducts, $500 per mile per annum, and for distribution ducts, 1 to 4 inches, $1,000 per annum.

As a duct of 3 inches diameter is generally in use by the companies named, the last charge provokes special protest. The finding of Col. Kearney, however, on the complaints investigated is that they cannot be justified by the conditions which exist. The figures submitted to him by the Subway Company show that the length of subways constructed to Jan. 1, 1890, for telegraph and telephone work was 501 miles, and for electric light and power 515 miles, making a total of 1,016 miles. The cost of construction and expenses during construction, consisting of repairs, alterations, ventilation, maintenance and interest on loans from 1886 to 1890 was $4,827,647. The subways occupied to May, 1890, are: telegraph and telephone, 188 miles; electric light and power, 216 miles, or a total of 404 miles, productive of an annual rental of $388,771. The annual expenses of the Subway Company are placed at $826,382, consisting of interest on bonds, $285,000; depreciation of plant, $241,382; operating expenses, taxes, ventilation and contingencies, $300,000. This would make the annual deficit on the operations of the company $437,611.

Joseph N. Choate, who appeared for the United States Electric Light Company, called into question the value of the statement upon which Col. Kearney had based his figures. He protested that it was "a mere aggregation of figures, unsworn to and unsigned, and involving no responsibility." In his opinion the present charges involved the total annihilation of all the companies interested, excepting "those on the inside track." He insisted on the right of the Board to investigate the books of the Subway Company, and on this right being questioned, he read the paragraph of the contract in which it is clearly set forth.

After further discussion the Mayor said that many of the companies who had used the subways had paid no rent whatever, and, as a matter of justice, they should have at least half the fixed rental until a solution of the matter was arrived at. Mr. Lauterbach, on the part of the Subway Company agreed that if such amounts were eventually proved to be excessive the excess should be refunded. Further action was postponed until the 26th. inst.

Special Correspondence.

NEW YORK NOTES.

OFFICE OF THE ELECTRICAL WORLD,
167-177 TIMES BUILDING, NEW YORK, Sept. 22, 1890.

Infringement Suit.—For alleged patent infringement the Brush Electric Company, of Cleveland, O., has begun suit against the Sprague Electric Railway and Motor Company, of this city.

Edison Dividend.—The fourth quarterly dividend of two per cent. on the stock of the Edison General Electric Company (except such stock as is held in trust by the Farmers' Loan and Trust Company) has been declared by the Board of Trustees, due and payable on Oct. 3, 1890.

The Eagle Electric Company, of New York City, has just been incorporated with the Secretary of State, to manufacture and sell electrical apparatus for electric lighting, and electric instruments, and to supply and furnish light, steam and power. Capital, $200,000. Trustees: David May, Joseph B. Allaire and Benjamin Skinhardt.

Capital Stock Increased.—A certificate has been filed with the Secretary of State setting forth that the capital stock of the Edison Electrical Illuminating Company, of Brooklyn, has been increased from $600,000 to $1,500,000. The entire capital of $600,000 has been paid in, and the debts were less than $700,000 when the increase to the capital was made.

The International Okonite Company, composed of English capitalists, which recently located works at Passaic, N. J., for the manufacture of materials for electric companies, has given a mortgage to the Central Trust Company of New York for $500,000. The Trust Company guarantees the payment of the bonds issued by the company in this country.

The Consolidated Electric Storage Company, of this city, has appointed the following agents: Mr. Henry C. Eddy, 170 La Salle street, Chicago, Ill.; Messrs. Bemis & Perry, 21 Old Sentinel Building, Indianapolis, Ind.; Mr. H. P. Broughton, 401 Mermod-Jaccard Building, St. Louis, Mo. These agents are going actively into the work of storage battery installation for lighting and power.

Electricity on the Elevated Roads.—The managers of the elevated roads have by no means abandoned the plan to propel the trains by electricity. Mr. Russell Sage says the day is not far distant when electricity will supersede steam on the elevated roads and horses will be no more used on the surface lines. He believes the cost of operating the elevated lines could be reduced nearly 10 per cent. by the adoption of electricity.

The Seely and Taylor Manufacturing Company, of this city, have just closed a contract to fit out the Brazilian mail steamship "Vigilante," with an entire electric light plant. It will require 300 lights including boom lights and a search light of 4,000 c. p. The dynamo will have a capacity for 400 lights. This steamship is the companion to the "Seguranza," of which the electric plant was recently illustrated and described in THE ELECTRICAL WORLD.

Mr. Louis Walsh, who was for a long time connected with the Daft Electric Company, now the United Electric Traction Company, has associated himself with the Crosby Electric Company, of Sixteenth street and Fifth avenue, in this city. Mr. Walsh was very popular with the trade, and this company is to be congratulated upon securing his services. He will represent this company among the trade of the country and will attend to the home business generally.

Storage Battery Cars.—There are at present nine storage battery cars in service on Fourth and Madison avenues in this city. Beginning with the first of October, the cars running between midnight and the morning service will be exclusively electric cars. There will then be an opportunity of showing how much the electric cars can shorten the horse car schedule between 86th street and the Post Office, as they will have a clear track. The accidents and stoppages on this line are remarkably few in number.

Election of Officers.—At the annual meeting of the stockholders of the Consolidated Electric Light Company held last week the following gentlemen were elected directors: Hugh R. Garden, Geo. Westinghouse, Jr., Amos Broadnax, Jacob Hays, Thomas B. Kerr, Geo. H. Lewars and John Rooney. At a subsequent meeting of the directors Hugh R. Garden was elected president, Jacob Hays vice president, Geo. H. Lewars secretary and treasurer. The regular quarterly dividend of one and a quarter per cent. was declared payable Oct. 1.

New Phonograph Company.—A certificate of the consolidation of the Metropolitan Phonograph Company and the New York Phonograph Company, under the name of the New York Phonograph Company, was filed last week in the office of the Secretary of State. The capital of the new company, which equals the aggregate amount of the two companies, is $2,500,000. The trustees of the consolidated company are John P. Haines, of Toms River, N. J., and John D. Cheever, R. T. Haines, Noah Davis, William Fahenstock, W. Seward Webb and John L. Martin, of New York City.

Mr. C. W. Whitney, formerly with the Crosby Electric Company of this city, and a gentleman whose popularity is known in every city in the country among buyers of electrical supplies, has been secured by the Consolidated Electric Storage Company, 120 Broadway, as superintendent of Agencies. Mr. Whitney is well fitted for this position, and will prove a valuable man for the company. Since the publication of the advertisement calling for agents in every city and large town in the country, many prominent concerns have offered their services, and quite a number have been appointed.

Mr. Max Mayer has just patented a new motor of the single-magnet, two-pole, iron-clad type, with a laminated field and armature, by which it is claimed the cost of manufacture is greatly reduced. The whole of the magnetic circuit is stamped out of one sheet of metal, the number of plates being bolted together. The field coils are separately wound on spools and are slipped over the core. The ⅛ h. p. motor has a wooden base with brass bearings, while the motors from ¼ h. p. up are placed on an iron base, having iron standards and self-oiling bearings. We will soon be able to give details from the actual machines.

An important decree was obtained in the United States Circuit Court in favor of Mr. A. L. Bogart, of 22 Union Square, New York City, and the Electric Gas Lighting Company, of Boston, they having conjointly instituted suits against the firm of Fuller, Holtzer & Co. in the United States Circuit Court, district of Massachusetts, in which the defendants were charged with infringing letters patent No. 225,071, issued to Packard, and No. 232,304, issued to Sandford, wherein the defenses of want of invention and non-infringement were thoroughly presented to the court. Decree was ordered for complainants, and an application for rehearing therein, after full argument, was denied by the court.

Cause of Electrical Accidents.—Dr. S. S. Wheeler, of the Board of Electrical Control, has made his report to that body on the death of lineman Kopp, who was killed at Broadway and Thirty-fifth street last Monday night. He held that Kopp was responsible for his own death because he failed to wear rubber gloves, which the United States Company, on whose wires he was at work, had provided for him. As to the accident of Charles B. Young at Maiden Lane and Pearl street, Mr. Wheeler reported that it was not caused by an electric light wire, but by a district messenger service wire. The wire was loose and fell across the elevated railroad track. The wheels of a passing locomotive caught it and the other end of it was wound around Young's body, and he was lifted several feet in the air and then dropped to the sidewalk. The board adopted Mr. Wheeler's report.

Mr. P. B. Shaw, manager of the Williamsport and Lansinburg (Pa.) Edison central stations, was in town this week. Mr. Shaw was the first to install the three-wire system in connection with an Edison central station plant at Sunbury, Pa. This plant is still operating successfully, having increased its capacity every year. The plant was started in 1882, and completed July 4, 1883, under most favorable auspices, and its installation was celebrated on that holiday. The Williamsport and Lansinburg plants are noted for their paying operations. Mr. Shaw is using a Julien storage battery plant at his residence, two miles from the Williamsport station, in the suburbs, charging the batteries from this station, and is much pleased with its operation. He talks of adopting them in the stations to avoid running incandescent machines at night, and using the excess of current in the day for charging purposes. Mr. Shaw has been most successful in his enterprises by his shrewd and judicious management. From his success in these places he has given his aid to other stations throughout the country where he holds large interests. W. T. H.

NEW ENGLAND NOTES.

Branch Office of The Electrical World,
Room 8, Cook Building, cor. Franklin and Congress Sts.
Boston, Sept. 20, 1890.

The Electrical Engineering Class at Tufts College, near Boston, will contain about 25 members.

Hull, Mass.—The selectmen have granted a franchise to the Nantasket Electric Light and Power Company.

The Electric Gas Lighting Company of Boston has been appointed wholesale selling agents for the Thaxter electric lock.

The offices of the Perkins Electric Switch Company are in Hartford, Conn., not Boston, as the item in our issue of the 20th would imply.

Brockton, Mass.—It is said that 300 men will soon be put at work on the electric road between Whitman and Brockton, and that the contract calls for the completion of the work by Nov. 1.

The Thomson-Houston Motor Company announces that it is prepared to furnish motors for electric power in any part of the building at the big fair which opens at the Mechanics' Building, in Boston, Oct. 1.

Newton, Mass.—The Newton Street Railway Company will commence regular trips between Waltham and Newton next Sunday, having secured the necessary power to operate the cars through the day and until midnight. The power for the dynamos will be supplied by a new Armington & Sims engine.

The Berlin Iron Bridge Company, of East Berlin, Conn. has issued a catalogue which does it credit. It is well illustrated with interior views of buildings in which this company's roof trusses are used, among them being the station of the Narragansett Electric Light Company at Providence, R. I., the station of the Connecticut Electric Light Company at Waterbury, Conn., and many large factories and foundries.

Cohasset, Mass.—The individual members of the Board of Selectmen and Town Treasurer were served with a writ of injunction this week restraining them from paying out any of the town's funds for electric lighting. The injunction was granted by Judge Holmes, and is returnable October 1. It is said that the injunction was procured by summer residents living on Jerusalem road, who claim that the town has no right to expend money for lighting.

Mr. H. E. Chapman, well known in business circles of Boston, will hereafter act as assistant manager of the Russell Electric Lamp Company. Mr. A. W. Rounds, president of this company, has just returned from St. Louis, where, he reports, there was great interest taken in the Russell lamp, as it performed its work regularly and did all claimed for it. Mr. Rounds returns with a smiling countenance, the result of a pocketful of large orders received on his trip.

A New Firm.—Mr. Elliott O. Johnson, formerly electrical contractor at Lynn, Mass., and for a long time connected with the Thomson-Houston Electric Company, has joined forces with the Standard Supply Company, of Boston. Mr. W. E. Stow has also joined this firm, and agrees to see that all persons "get the best" in his line of electrical supplies. Messrs. Woodward, Johnson and Stow, who are to be known as "The Big Three," are well fitted to make a lively business firm.

The Thomson Scientific Club, of Lynn, Mass., will hold its first meeting after the summer vacation Oct. 4. The club has leased elegant quarters on the South street side of the Flagg and Breed block, with a frontage on Western avenue. They are on the second and third floors, the lower portion being occupied by billiard and reading rooms and other convenient apartments. On the third floor will be the lecture hall, large enough to seat 200, the secretary's office and a kitchen.

American Circular Loom Company, of Boston, Mass. has sent us a little pamphlet calling the attention of electric light, telephone and telegraph companies, and users of insulated wires and cables generally, to its new method of insulating. The pamphlet gives prices of the company's numerous varieties of wires; and also contains useful tables regarding the weight, resistance and size of various copper wires. The report made to this company by Wm L. Puffer, of the Massachussetts Institute of Technology, on the insulation of wire, is also incorporated in the pamphlet.

The Jewell Belting Company, of Hartford, Conn., has issued a little pamphlet giving a few general rules for the care and use of leather belting. This company manufactures pure oak short-lapp leather belting, and laced belting, and has embodied in this pamphlet some general rules for the care of such belts, and some valuable tables concerning the number of horse power that can safely be transmitted by single and double leather belting of various kinds; it also contains excellent cuts of the company's tanneries at Jellico, Tenn., and Rome, Ga. The pamphlet will be valuable to purchasers and users of leather belting.

Mr. F M. Kimball has recently made the following shipments and installations of his standard dynamos: One 75-light to E. O. Hall & Son, Honolulu, Sandwich Islands; one 30-light to Hagaman & Park, New Bedford, Mass.; one 50-light to Thos. L. Appleton, Chelsea, Mass.; one 15-light to W. H. Luther & Son, Providence, R. I.: one 10-light house plant to Miguel Samper è Hijos, Bogata; one 10-light house plant to Maracaibo; one 75-light plant to the Meridith Shook and Lumber Company, Meridith, N. H., and one 20-light to Chandler & French, Barton Landing, Vt. He is also building two dynamos, one of 3,500 watts and one of 2,000 watts capacity for charging storage batteries for the Acme Primary and Storage Battery Company, of New York. L. H. H.

PHILADELPHIA NOTES.

Branch Office of the Electrical World,
31 City Building, Philadelphia, Sept. 20, 1890.

Lebanon, Pa.—C. M. Blanchard, of Philadelphia, has just fitted up the house of Robert Coleman for 225 incandescent lights with tubing of the Interior Conduit and Insulation Company's system.

The Brush Electric Company has sold the Sunbury Electric Company 60 arc lights, and about five miles of construction work has been done by Mr. C. M. Blanchard. It is said to be one of the finest pole lines in the State.

The Campbell & Zell Company, of Baltimore, Md., has sold a 500 h. p. Zell improved water tube boilers to the Edison Electric Light and Power Company, of Erie, Pa., and a 300 h. p. to the Johnson City Electric Company, of Johnson City, Tenn.

W. S. Griffith & Co., agents for the Mather Electric Company, have installed for Messrs. Pedrick & Ayres, machine tool builders, Tenth and Hamilton streets, 200 additional electric lights. This is the third installation of Mather apparatus made for this company.

Nicetown, Pa.—The Link Belt Engineering Company has ordered from Messrs. M. R. Muckle, Jr. and Co., of Philadelphia, a 35 h. p. Westinghouse engine and a 400 light United States dynamo. The shop is to be wired up in 16 circuits, all controlled from the dynamo room, making the engineer responsible for the proper lighting at different hours, and avoiding the waste of light by the careless burning of the lamps.

Morton, Pa.—The Faraday Heat, Light and Power Company has been incorporated here with the following officers: Richard Young, president; W. J. Bankard, secretary; William Dolbey, treasurer, and William L. Voelker, superintendent. The capital stock is $35,000. The officers have contracted with Mr. C. M Blanchard, of Philadelphia, for a 500-light dynamo of the National Electric Manufacturing Company's make, and six miles of construction work. They expect to increase their plant to 1,500 lights within a month.

Prospecting.—Mr. C. M. Blanchard, accompanied by Mr. L. R. Schultz, have just returned from a business trip through North Carolina, South Carolina, Virginia and West Virginia. They have also visited New York, Boston and several large cities in New England. While in the South they estimated on contracts to the amount of $250,000, some of which they expect to close during the coming week. They received great encouragement from nearly every point visited, and say the outlook in the electrical field is very bright. Mr. Blanchard has just taken the agency for the Western Electrical Company, of Chicago, and the Schaefer Electric Manufacturing Company, of Boston, for the Middle and Southern States. W. F. H.

WESTERN NOTES.

Branch Office of The Electrical World,
465 The Rookery, Chicago, Sept. 20, 1890.

The Chicago Electric Supply Company has been incorporated to sell electrical goods and patent same. Capital stock, $100,000. Incorporators, H. B. Hillock, C. P. Chapman and F. W. Parker.

An Elaborate Catalogue.—The Central Chandelier Company, designers and makers of gas, electric and combination fixtures, at Toledo, Ohio, has issued, for the use of customers, a superb catalogue containing well-executed illustrations and engravings of a great variety of its gas, electric and combination fixtures. These are shown in a great variety of designs, for use under all circumstances which arise in interior decoration. Interior views of the company's salesrooms are also shown in colored engravings, and these exhibit a splendid display of the company's goods.

Telephone Quotations.—Col. S. G. Lynch, broker, 153 Monroe street, Chicago, furnishes quotations on telephone stocks as follows:

Chicago	$298@$300	Cumberland	$ 59@ $60
Central Union	62@ 64	Wisconsin	117@ 118
Michigan	97@ 99	Bell of Missouri	155@ 160
Great Southern	32@ 35	Iowa Union	20@ 21
Colorado	38@ 40	Missouri and Kansas	55@ 57
Rocky Mountain Bell	40@ 45		

ELECTRIC LIGHT STOCKS.

Chicago Arc Light and Power	$104@$105	Chicago Edison Co	$130@$132

Minneapolis, Minn., Sept. 17, 1890.

The Minneapolis Exposition, always an attractive spot for thousands of visitors, has been made doubly so this year by the addition of electrical exhibits of value to ever one.

Mr. M. E. Baird and A. D. Newton talked up the merits of the Eddy motor.

The C. & C. Motor Company, of New York, had no exhibit, but was ably represented by Mr. H. L. Lufkin.

Mr. R. B. Carey, of the Supply and Construction Company, New York, brought out the good points of the Ward lamp for use on incandescent circuits.

The R. J. Clark Company, Minneapolis, is exhibiting cross arms, pins and brackets for telephone and electric light work, which they have manufactured.

Mr. C. J. Thomson, of St. Paul, has on exhibit a Detroit motor, a Continental dynamo, and a Cincinnati Electric Engine Company's motor; also, a full line of Hazazer & Stanley's house goods.

Mr. E. T. Greenfield escorted engineering electricians to his splendid exhibit in the exposition building, where all forms of interior and underground conduits may be seen.

The Carpenter-Nevins Electro-Heating Company, of Minneapolis, is exhibiting various forms of electrical apparatus, designed for cooking, broiling, soldering, pressing, ironing of cloth and of hats, etc.

Mr. A. T. E. Wangerman, of New York, is educating the visitors to appreciate the great value of the phonograph as a time saver, and his success has been remarkable, showing that earnest systematic work will overcome any difficulty.

The Northwest Thomson-Houston Company, of St. Paul, has rather an extensive display of electrical machinery and supplies, and the Minnesota Electric Company, Minneapolis, displays a line of fixtures and house goods.

Mr. J. F. Kelly accompanied the New York delegation nearly to Minneapolis and then switched off, knowing that his most excellent exhibits of wires, cords and conductors in the exposition building would prove irresistible to the central station buyer.

Mr. Robert Coleman, representing Chapman & Meehan, 140 Franklin street, New York, is introducing the supplies of the New York Wood Fibre Company through the Northwest. Mr. Coleman's jolly countenance is well known to all convention-goers, to the majority of whom he has explained his new system of suspension.

The Thomson Electric Welding Company, of Boston, has an extensive display, including a 60,000 watt generator, five welding machines and a pneumatic hammer for removing the burrs on pipe. Then there are sample boards showing work that has already been done in welding together metals of different character. Mr. W. S. Gorton, Mr. A. E. Pond, and Mr. N. H. Beggs are the gentlemen in charge.

The Edison Exhibit.—First in importance is the Edison display, which attracted so much attention at the Paris Exposition. The telegraph, telephone, and phonographic apparatus, the cases of bamboo sections and of filaments of various forms; the talking dolls, etc., are shown. Then there is the 70 foot octagonal tower, with its varied Egyptian forms worked out in small incandescent lamps, with festoons of colored lamps suspended from the top to the adjoining walls, while around the base runs on a circular track a miniature electric train drawn by an electric motor car, the track being supplied with block signals, etc. Altogether it is an exhibit that has won the admiration of every visitor, and Mr. E. W. Hammer can well feel proud of his work. The Edison General Electric Company has a very complete line of wires, cords, and all the material used in constructing a complete underground system.

The Interior Conduit and Insulation Company, of New York, has an extensive exhibit that is attracting the attention of not only electricians, but also of architects and insurance men who have awakened to the fact that "electric light wiring can only be done economically and effectively by the establishment of centres of distribution wherefrom to radiate all minor branches." Within a handsomely arranged space the company shows sections of its insulating conduits ranging in size from the smallest to the largest, and suitable for interior or underground service; elbows, couplings, threading tools, junction boxes, porcelain cut-outs, feeder terminals, spring ceiling pendant, and ceiling connecting boxes. The company also has a permanent exhibit in the 150 miles of conduit now in use in the street railway work. The display was designed by Mr. Edwin T. Greenfield, the electrician of the company in New York.

Memphis, Tenn., Sept. 16, 1890.

New Central Station.—The first story of the building for the Memphis Electric Light and Power Company is up and work is progressing rapidly.

Progress in Railway Work.—Work on the city and suburban electric road is almost completed, and it is expected to have cars running by Oct. 1.

Mr. T. H. Allen, Jr., the president of the Memphis Belt Electric Railway Company, has closed a contract with the Westinghouse and Pullman Companies for motors and cars for that road.

New Electric Light Plant.—An agent of the Thomson-Houston Electric Company, from Atlanta, Ga., closed a contract with Col. W. A. Collier to put a plant of 300 lights, of 16 c. p. each, in the Collier building. The contract includes dynamos, wiring, lamps, etc.—everything ready for the belt from the engine.

Louisville, Ky., Sept. 16, 1890.

May Possibly Strike.—There is some talk here of a strike on all the street car lines during the fall celebration, including the electric lines. The drivers and motor men demand a little more money and somewhat different hours.

Mr. J. B. Quin, of this city, has become the general agent of the National Electric Manufacturing Company, with headquarters here at 200 West Main street. The principal office and works of this company are at Eau Claire, Wis.

Railway Work.—The work of turning the street car lines in Fourth, Market, Shelby, Eighteenth and Chestnut streets from mule lines to electric lines progresses rapidly. On the Fourth street line the work will be done first, and all the work will be done within the time specified.

The Gaynor Electric Company, which owns patents and manufactures electrical appliances in this city, has just secured an order to furnish the city of San Antonio, Tex., with a complete fire alarm telegraph system. For this purpose $25,000 has been appropriated. The Gaynor Company has also, within a few weeks, booked orders for fire alarm systems for Branford, Ont., and West Toronto, Can. F. de L.

ENGLISH NOTES.

(From our own correspondent.)

London, Sept. 10, 1890.

The Telpher Line at the Edinburgh Exhibition.—The telpher system of electric traction, which was devised some years ago by the late Professor Fleeming Jenkin, though hailed at the time with considerable enthusiasm, has, like most methods of electric traction, failed to make the progress in this country that was anticipated. However, since the patents have been acquired by the Electrical Engineering Corporation, the system has been modified in detail and is being more vigorously pushed. The corporation has a short line at the Edinburgh Exhibition. The greater part of the track is flexible, the cars being suspended from 1⅛ inch ropes of crucible steel, the ropes being strung on stout supports 50 feet apart. Each train on the line consists of three cars and a locomotive, the latter comprising a tub swung from a frame running on the steel ropes and containing the motor, which drives a small countershaft. The countershaft has on it a chain wheel, which drives directly on to a larger chain wheel attached to the upper frame. The upper frame contains, in addition to the large chain wheel two driving wheels

with malleable cast iron tires to grip the rope, each attached to a chain wheel driven from the shaft supporting the large central wheel. This method of transport has attracted considerable attention in England in view of the many instances where telpherage might be advantageously employed, and the bringing of the system prominently before the public ought to lead to many practical applications.

Brush Electrical Engineering Company.—The first annual general meeting of the shareholders of this company, which may be termed the premier company in England, was held on Monday, and the chairman was able to present a very satisfactory report as to the present condition and future prospects of the company. The Brush Electrical Engineering Company is the new title of the old "Anglo-American Brush Corporation" which, some 12 months ago, amalgamated with its Australian, Indian, and Austrian off-shoots, and purchased some fine works, seven acres in extent, at Loughboro, to enable it to tackle the heaviest engineering work. The company, although strictly speaking a manufacturing one, has already secured several provisional orders, and is taking steps to secure several more; no doubt with a view of disposing of the powers so obtained, since it would be impossible with its small share capital (£127,000) to carry them out on its own account. The most valuable order it has obtained is for the lighting of the centre of the city of London, which alone will absorb £300,000. The chairman announced that the compound winding case, which has already passed through two Scotch courts, with adverse decisions to the company, will be carried to the House of Lords. He also announced that the profits would permit of the payment of the full preferential dividend of 6 per cent., and that sufficient money remained to pay the ordinary shareholders 3 per cent., but that he thought it wiser to strengthen their reserve fund.

News of the Week.

THE TELEGRAPH.

Cable Communication Restored.—Telegraphic communication with Guatemala and Honduras has been restored via the Central and South American Telegraph Company's cables. The governments are now adjusting telegraph accounts, and it is expected that hereafter messages will be accepted and forwarded without delay.

Telegraphers Elect Officers.—At the convention of old-time telegraphers held in Kansas City, Mo., last week, the officers of the association were re-elected as follows: President, W A. Plum, of Chicago; vice-president, W. B. Wilson, of Harrisburg, Pa.; secretary and treasurer, J. E. Pettit, of Chicago. Washington, D. C., was decided on as the place for holding the next annual meeting.

THE TELEPHONE.

An Interesting Decision.—At Wheeling, W. Va., on the 12th inst., Judge Jackson delivered a decision in the case of Arkel vs. the Wheeling Telephone Company, growing out of a change insisted upon by the company a year ago, whereby subscribers were compelled to ask for numbers instead of names. Arkel refused to call for numbers and brought suit for damages. The court held that the company had a right to determine the manner and mode of making the connections.

Telephone Tower Struck.—The tower of the New York and New Jersey Telephone Company, on the Fleming building, in Jersey City, was struck by lightning last week and set afire. The top floor, where there are 14 rooms, was occupied by the telephone company. In the switch-room 20 girls were hard at work when the fire broke out. The lightning was communicated to the building by one of the wires running into the tower. Considerable damage was done to the 2,000 wires and cables entering the tower, but the switch-board was not injured. All connection with New York was cut off for a day.

THE ELECTRIC LIGHT.

Blaine, Wash.—The Blaine & Semahmoo Electric Light Company has been incorporated with a capital stock of $100,000. Incorporators, Wm. H. Pickney, S. P. Hughes, Fred W. Power, Thos. Payne and F. W. West.

At Monongahela City, Pa., the poles are all up for the electric light line, and the wires are being strung. The dynamo is in place, and all the machinery except the boiler. The entire plant will soon be ready to start up.

Mr. Arthur Hartwell, one of the electrical experts in the employ of the Westinghouse Electric & Manufacturing Company, went last week to Portland, Ore., where he will superintend the construction of the plant of the Willamette Falls Electric Lighting Company. The Willamette company will employ water power located 12 miles from Portland. Special 2,000 volt apparatus will be used.

A Navy Yard Plant.—The Thomson-Houston Electric Company has been awarded the contract for an electric light plant at the Mare Island (Cal.), Navy Yard for $44,900. This is considered a very reasonable figure, and will leave the department with enough to begin the projected plans at the New York and Norfolk yards. It is part of a general plan which contemplated electric plants for four navy yards.

Westinghouse Exhibit at the Pittsburgh Exposition.—We have received a set of very handsome photographs showing the magnificent display of Westinghouse apparatus at the Pittsburgh Exposition. The exhibit includes a 3,000-light alternating dynamo, operated exclusively to light up an illuminating sign put in the form of an immense arch carrying the words, formed of over 2,000 incandescent lamps, "Westinghouse—Pioneers of the Alternating System." A large number of smaller machines and Tesla's motors, well arranged, make the display one of the finest ever attempted by any electrical company.

APPLICATIONS OF POWER.

Twelve Julien cars are now in service in Birmingham, England, and are reported by Mr. Pritchard, the engineer in charge, as doing excellent service.

A Big Dynamo.—The castings for a 2,400 light dynamo machine are ready to be assembled in the factory of the Thomson-Houston Electric Company at Lynn. This will be of 200 h. p., ten more than that of the big street railway generator now set up in the welding works.

Storage battery traction is being rapidly pushed in New Orleans. Eight cars have just been received there from Brill & Co., to be followed by 22 more. Thirty cars in all are to be installed within the next few months. Thirty trucks are already mounted with motors and prepared to receive the car bodies.

The Greensburg Electric Street Railway Company has linemen at work putting up the trolley wires. The dynamos, engines, etc., at the power house are in position and almost ready for use. A good part of the track has been graded and is in readiness for the rails. The company proposes to have the cars running by Oct. 2.

An experimental conduit for electric railways is being constructed between the Federal street tracks of the Thomson-Houston Company, at Lynn, Mass. It is said to be a Thomson-Houston invention. The company advocates the overhead system, but proposes to be so well prepared that it can lay conduits in cities where the drainage is such as to make it practicable.

The new Westinghouse motor, which has been in operation on the Pleasant Valley Electric Railway, Allegheny, Pa., for a week, has been the subject of daily conversation among parties interested in the electric motor business. The patrons of the road are said to be perfectly delighted with it. They have named it the "Noiseless," and it is not an unusual thing for people to let several cars go by and wait for No. 130, the car fitted up with the Westinghouse motor. One of the officials of the Pleasant Valley company, who has made the electric motor a study, and who has had experience with all of them, in answer to a series of questions as to the distinctive points of the Pittsburgh street car motor, said: "There is above all the wonderful ease and quietness of operation, which causes the cars to run along with a wonderful smoothness and silence. This noiselessness makes the car at once conspicuous on our line, and there is hardly a passenger on the route to-day who does not know the 'Noiseless.' People are enabled to converse even in an ordinary tone of voice on the car, and the residents along the line have great praise for it. The car has been running 167 miles each day since the first day of its operation, which is 47 miles a day more than any other car runs. That is, of course, because we run the car all night and thus are able to accommodate the traveling public without having our cars become a nuisance to the people who are desirous of having a night's rest undisturbed by the rattling and grating of the street car motor."

MISCELLANEOUS NOTES.

Quotations on Electrical Stocks.—Mr. F. Z. Maguire, electrical securities, of 18 Wall street, this city, reports the following quotations of Saturday, Sept. 20, from New York, Boston, and Washington:

NEW YORK.

	Bid.		Bid.
W. U. Tel. Co.	82	Edison Gen. Elec. Co.	100
American Tele. & Cable	83	Edison Gen. Co. Def'd	....
Cent'l & So. Amer.	157	Consol'd Elec. Lt. Co.	60
Mexican	205	Edison Ill'n'g Co., N. Y.	....
Com. Cable Co.	*101⅛	U. S. Elec. Lt. Co.	35
Postal Tel. Cable	39		

BOSTON.

	Bid.		Bid.
Thomson-Houston	48⅛	Ft. Wayne Co.	11¼
" Pref'd	25¼	Am. Bell	226½
" Series C.	12	Erie	48¼
" " D.	6	New England	51
" Int. Co.	....	Mexican	.90
Thomson Welding Co.	....	Trop. American	....
Thomson Eu. Welding	72	Edison Phon'gph Doll.	2

WASHINGTON.

	Bid.		Bid.
Penna. Telephone	25	U S. Electric Lt. (Wash.)	168
Ches. & Pot. Telephone	71	Eck. & Sold. Home Elec. Ry.	68
Amer. Graphophone	16⅝		

* Ex dividend.

PERSONALS.

Capt. Eugene Griffin, of the railway department of the Thomson-Houston Electric Company, was entertained last week at a dinner given by a company of 50 of his business associates.

Mr. H. S. Manny, of the Chicago office of the Thomson-Houston Electric Company, has received a very handsomely engraved gold-headed cane from the traveling electrical experts of the company.

Ensign John S. Watters, U. S. N., whose resignation was accepted, to take effect December next, has established himself in business with the Edison General Electric Company, and is located for the present at New Orleans, La.

E. P. Howe, Esq., legal counsel for the Thomson European Welding Company, with Mr. Wallace, a barrister, of London, who is counsel in that city for the company, visited and inspected the welding factories at Lynn, Mass., last week.

Mr. George M. Pullman says: "No consolidation of the Westinghouse Company with Pullman was ever dreamed of. Negotiations are simply under way for the building of a factory for the Westinghouse Company at Pullman. It will cost about $500,000."

Mr. Gardiner C. Sims, of the Armington & Sims Engine Company, Providence, R. I., has been appointed a member of the Committee on Tariffs and Transportation of the World's Columbian Commission, a member of the Committee on Manufactures, and chairman of the Committee on Electricity and Electrical Appliances.

Industrial and Trade Notes.

The American Circular Loom Company will at once increase the size of its plant at Hanover, Mass., to double its present capacity. The growth of its business has been remarkable, and the outlook for the coming year is very encouraging.

Graphite Bushings.—The Akron Street Railway Company are using graphite bushings on the trolley wheel to great advantage. The company which operates the Sprague system was the first to introduce this material in the trolley in May, 1889.

C. H. Brown & Co., manufacturers of the celebrated "Brown" engine, Fitchburg, Mass., are doing a nice business with electric people not only in this country, but in foreign countries. Orders have been received recently from Denver, Colo.; Rio de Janeiro, S. A; Paris, France, and from Antwerp.

The Electro-Pneumatic Time Company, 45 Broadway, this city, has introduced its system of distributing time in the Aldrich Court Building. Its operation has been so successful as to secure from the owner, Mr. Spencer Aldrich, an excellent testimonial. The company is now making arrangements to introduce its system into the principal office buildings of this city.

The Park Manufacturing Company, of Boston, has recently installed two injectors of the very largest size, requiring special patterns and three inch connections, at the plant of the Worcester Electric Light Company, Worcester, Mass. Others have also been installed at Cambridge and Plymouth, Mass. This company will make an unusually fine display of its injectors and ejectors at the Mechanics' Fair which opens soon in Boston.

The Manhattan Electrical Supply Company, 36 Cortlandt street, has added to its "early riser's" clock a base and monitor bell, with a good dry battery in the base to operate the bell. This company's acoustic telephones are meeting with excellent success, a large number being in operation. Numerous testimonials can be shown of their successful work, and the company is constantly adding new machinery for the manufacture of electrical supplies.

The New York Belting and Packing Company, New York, received the very large order given for belting for the large new elevator erected in this city by the New York Central & Hudson River Railroad, there being an aggregate of 71 belts, all rubber and of its manufacture, among which were 19 elevator five ply bucket belts, each 313 feet long and 22 inches wide. The main driving belt is 350 feet long, 52 inches wide and eight-ply thick. This belt was for some time on exhibition at the manufacturers' principal offices and salesrooms, 15 Park row, New York, where it attracted considerable attention.

Information for Users of Electrical Instruments.—The Weston Electrical Instrument Company, of Newark, N. J., has issued a pamphlet giving minute descriptions of its testing instruments, including the Weston direct reading voltmeters and ammeters, and also giving general directions for their use. The catalogue is well illustrated, and contains some testimonials from users of these instruments, among them being Leo Daft, Herman Lemp, of the Thomson Electric Welding Company; A. L. Rohrer, of the Thomson-Houston Electric Company; P. H. Alexander, of the Sawyer-Man Electric Company; Geo. B. Prescott and Prof. George Forbes.

The Hall Signal Company, whose principal office is at 50 Broadway, New York City, has issued a catalogue containing descriptions of its system of railway signals. This system was fully described and illustrated in the ELECTRICAL WORLD last month. The catalogue contains illustrations printed in colors wherever necessary to show the working of the signals. Numerous diagrams are given, showing the block signal and other circuits, and also the system of interlocking. The catalogue is an elaborate affair, and the company deserves great credit for thus placing in the hands of their customers such a splendid description of its signaling system.

Answers to Correspondents.

Questions to be answered in this column must be of general electrical interest, and must be accompanied by real name and address as a guarantee of good faith. No notice will be taken of questions regarding apparatus unless enough details are given to permit a definite answer, and no dynamo or motor designing will be done.

Small Dynamo.—I wish to build a small dynamo, and would like to receive information on the following points: (1) Can good cast iron be used for pole pieces of a machine having wrought iron cores—the intended output to be about 400 watts? (2) What is a good metal from which to make commutator segments? (3) Could such a dynamo be run as a motor?

(1) Cast iron will answer for the purpose, but it should be of good quality, and carefully annealed. (2) Gun metal. (3) Yes Any continuous current dynamo can be run as a motor, but it usually requires a slight shifting of the brushes backward from the direction of rotation in order to get good results.

Testing for Ground with Lamps.—Will you please tell me how the ground lamps on the Edison two-wire system work?

H. E. S.

The system is a very simple one. Two or more lamps are connected in series across the main, and the middle point of the series is connected to ground. A small quantity of current then continuously flows through the lamps, lighting them, generally rather faintly. If the ground occurs either on the positive or negative wire, the lamps on the corresponding side of the ground wire will receive less current than those on the opposite side. The resulting difference of brightness locates the side on which the ground has occurred, and, very roughly, the severity of the ground.

A Medical Coil.—Would you kindly give me information about making an induction coil for shocking purposes, what size of wire to be used and how much?

J. J. C.

For winding see answer above on "induction coils." The core should be of small iron wire, carefully straightened and bound together into a close bunch. On a thin paper tubing outside, wind primary, say No. 20 wire, nearly full length of the core, about three layers deep. Insulate with shellac and cover with tough shellac paper. Wind on secondary above this of No. 36 or 38, filling the bobbin—the complete bobbin would be perhaps one and a half inches in diameter. Use magnetic make and break such as you would find in any small induction coil, and one or two cells of bichromate or good dry battery. You cannot expect to get a severe shock from a coil of this size, still it would make its existence tolerably evident.

Induction Coils.—(1) Can you tell me through your correspondence column what size wire I should use in the construction of induction coils three inches long, one and one-quarter inches in diameter and three-eighth inch cores. (2) What pocket battery would you recommend for running the same? (3) With what size wire should a two and one-half inch drum armature be wound if the fields were wound with No. 19, running in series? C. C. W.

(1) Wind primary with No. 18 to 20; secondary with No. 36 to 40. This amount of latitude is given as it may be inconvenient to get the smaller size of wire. Insulation should be very carefully done, using plenty of shellac. (2) If it isn't necessary to have a portable battery, better use a bichromate plunge battery. If the battery is to be portable, use a chloride of silver battery, or any of the dry batteries that can be readily obtained. (3) Question unanswerable without further details. No. 19 is too small for a series machine of proposed dimensions.

Business Notices.

Battery Cut-Out, Cheap.—Sensitive, reliable, never requires attention. Gas lighting much improved by its use. Electric Supply Co., of 105 South Warren street, Syracuse, N. Y.

An Electrical Agency.—Messrs. Meserole & Co. have fitted up offices at 26 Church street, this city, and propose to offer their services as agents for any new or established electrical articles that could be exhibited or exploited to advantage. Any small apparatus will be exhibited in operation and its advantages explained to prospective investors. Mr. A. V. Meserole has had a large experience in the electrical business and is well fitted to carry on such a business with considerable advantage both to himself and his clients.

OUR ILLUSTRATED RECORD OF ELECTRICAL PATENTS

U. S. PATENTS ISSUED SEPT. 16, 1890.

436,334. Telephone; William Burnley, of North East, Penn., Assignor of two-thirds to Charles A. Hitchcock, of same place, and Lewis F. Watson, of Warren, Penn. Application filed August 11, 1887. In a telephone transmitter, the combination of a diaphragm, an electrode affixed thereto, an inclined plane, a loose electrode resting on said plane and in contact with the diaphragm-electrode, and means for elevating and lowering the electrode-supporting plane without altering its inclination.

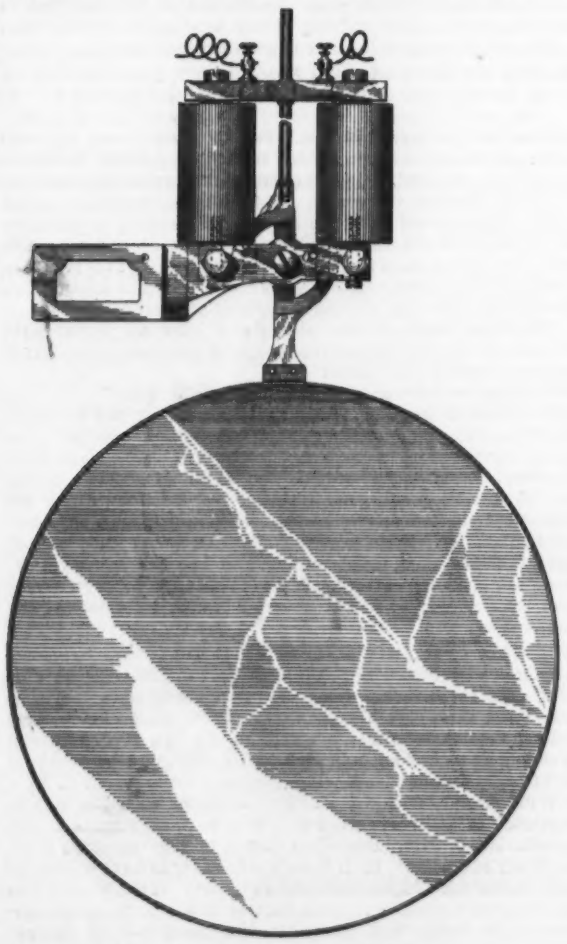
436,335. Telephone; William Burnley, North East, Penn., Assignor of two-thirds to Charles A. Hitchcock, of same place, and Lewis F. Watson, of Warren, Penn. Application filed August 11, 1887. In a telephone-transmitter, the combination with a diaphragm and its electrode of an inclined plane or platform, ribs applied to its top surface to form guard-rails and a guideway, and

No. 436,354.—ELECTRIC CIGAR-LIGHTER.

a loose spherical electrode placed between said guard-rails and making contact with the diaphragm electrode.

436,354. Electric Cigar-Lighter; Mortimer M. Hayden, of New York, N. Y. Application filed April 29, 1890. The method of igniting an inflammable substance, which consists in passing a piece of conducting material bearing such substance between the terminals of an electric circuit.

436,371. Railway Signal; Preston C. Morse, of Natick, and Henry D. Winton, of Wellesley Hills, Mass., Assignors by mesne assignments, to the Hall Signal Company, of Portland, Maine. Application filed May 22, 1889. The combination, with an elec-



No. 436,371.—RAILWAY SIGNAL.

tro-magnet having prolongated poles, of an armature, pivoted between said poles, and having curved wings extended in the direction of the length of the axis of the said armature and arranged between said poles and provided with straight and inclined edges, the latter edges being inside of the ends of said poles and the straight edges being outside of the ends, and a signal target or disc connected to the straight side of the armature.

436,387. Socket for Incandescent Electric Lamps; Horace E. Swift, of Boston, Mass. Application filed Nov. 1, 1889. In an electric switch, a metallic standard in contact with a lamp terminal and provided with a rotary conducting cam, a spring electrode in contact with and actuated by the cam, and a fixed electrode arranged opposite thereto, whereby direct electrical connection may be effected between said terminal and the fixed electrode.

436,408. Dynamo-Electric Machine; Stephen Dudley Field, of Yonkers, N. Y. Application filed April 2, 1888. The invention comprises a single dynamo-electric machine of shunt-wound character, having its armature composed of two or more independent windings, each complete winding connected with its own separate commutator on the shaft and having its own collecting brushes, the field being composed of a number of shunt windings forming each a proportionate part of the total field, and each pair of brushes forming the terminals of one of the working circuits of the multiplex system.

436,410. Electric-Magnetic Bell; John Geary, of Philadelphia, Pa. Application filed Dec. 18, 1889. The combination, in an electro-magnetic device of a magnet having two armatures differently adjusted, two circuits, a battery, and conductors of unlike resistance permitting variation in the strength of said magnet.

436,412. Electrical Switch; Frederick D'A. Goold, of New York, N. Y. Application filed July 15, 1890. In an electrical switch, an oscillating lever having a V-shaped projection at its central point, in combination with a pin on a sliding flexible spring, said pin being capable of sliding down the V-shaped projection when turning the switch on or off.

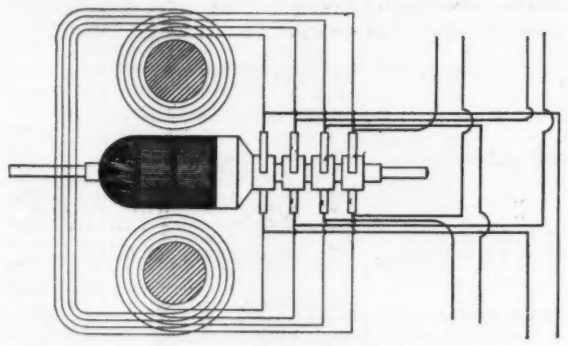
436,425. Electric Railway; Hosea W. Libbey, of Boston, Mass. Application filed Nov. 14, 1889. In an electrical railway, a series of columns, each having a bracket and a bifurcated arm, the outer end of each prong forming a contact point, all of which points are connected to a positive electric conductor laid underground.

436,432. Electric Conductor; William Edward Oehrle, of Philadelphia, Pa., Assignor to Oehrle Bros. & Co. Application filed May 28, 1890. A flexible electric conductor consisting of a core covered with an insulating material, a moisture-repellent material consisting of a longitudinal strip of rubber, and insulating material consisting of fibrous material coated with a non-inflammable composition, and an exterior braided covering.

436,439. Electric Motor Car; William Robinson, of Boston, Mass., Assignor to the Robinson Radial Car Truck Company, of Portland, Me. Application filed April 12, 1889. In a railway car or truck, the combination of a swiveling axle frame, and axle frame adapted to move transversely relatively to the main truck or car frame, and bars or brackets rigidly secured to said axle frames and adjustably connected to each other, one of said bars or brackets being provided with a pivotal bearing engaging in a longitudinal bearing or slot in the other bar or bracket whereby flexible movement without strain is provided for between said swiveling and transversely moving axle frames.

436,440. Electric Motor Car; William Robinson, of Boston, Mass. Application filed Sept. 16, 1889. The combination of a motor car or truck, a motor arranged to drive the same, and curved guides between said motor and the axle which it drives, said motor being flexibly supported by said axle and adjustable in the line of said curved guides.

436,465. Arc Lamp; Charles A. Tucker, of Islip, New York. Application filed Jan 3, 1888 A device for regulating electric arc light carbons, consisting of a support for the carbon holder which will retain the same in any desired position firmly but not



No. 436,408.—DYNAMO-ELECTRIC MACHINE.

immovably, a bearing adjusted to such carbon holder, and a suitable part capable of being expanded by heat and contracted by cold, as a rod of metal, one part of which is held rigidly in position and another part of which is adjusted to operate upon such bearing, in combination with a suitable shunt adapted to divert the current from the carbon circuit into the expansible part as the resistance in the carbon circuit increases, and thereby to expand such expansible part and force the carbon rods together to the desired distance.

436,512. Telephone; S. Lloyd Wiegand, of Philadelphia, Pa. Application filed May 28, 1889 In an apparatus for transmitting sounds and signals, the combination, with a diaphragm and a helix located in proximity thereto, of an expansible core attached at one end to the diaphragm, said core being composed of a series of plates arranged in pairs, the ends of each pair of plates being secured together and the several pairs of plates being connected together at their centres.

436,513. Telephone; S. Lloyd Wiegand, of Philadelphia, Pa. Application filed May 28, 1889. In a telephone-transmitter, the combination, with a diaphragm having an electrode permanently connected so as to vibrate therewith, of a loosely-mounted electrode resting normally against the first electrode and arranged to be propelled by vibrations of the diaphragm and its connected electrode toward the speaker and make variable contact during ensuing reaction.

436,514. Telephone Relay; S. Lloyd Weigand, of Philadelphia, Pa. Application filed May 28, 1889. In an electrical apparatus, the combination, with two electrodes, one arranged to be actuated by gravity, of an expansible magnetizable core, a helix encircling the core, and devices connecting the core with one of the electrodes, the parts being so arranged that on the expansion of the core by the action of the current flowing around it the contact of the electrodes will be diminished and subsequently increased by the gravitation of the free electrode.

436,516. Galvanic Battery; John F. Wollensak and William E. Gill, of Chicago. Application filed May 13, 1890. In open-circuit batteries, the combination of a cup having holes through its sides, a carbon stick having a hole in a position and direction to be brought into a line with the holes in the cup, and a pin of non conducting material passing through the holes in the cup and stick.

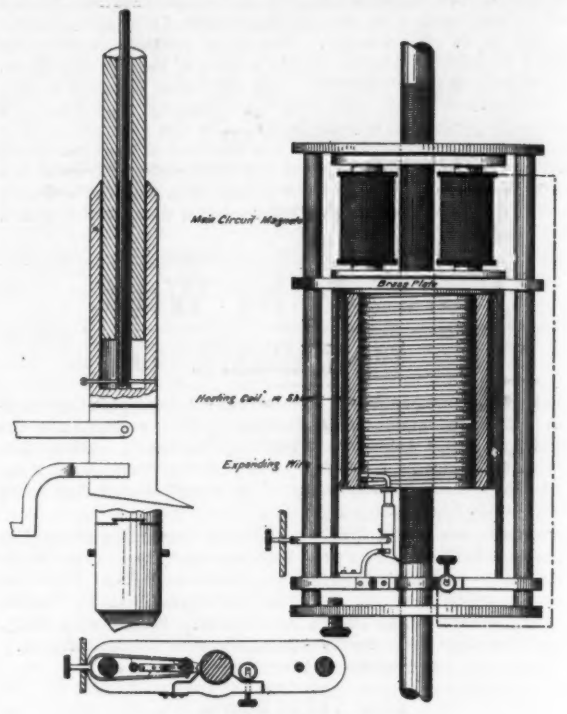
436,519. Method of Electrically Heating Bars, etc., for Welding and Working Purposes; Mark W. Dewey, of Syracuse, N. Y., Assignor to the Dewey Corporation, of same place. Application filed June 9, 1890. The method for electrically heating bars or blanks for welding and working purposes, consisting in embedding the bars or blanks in a yielding bed of conducting material, passing a heavy electric current through said bed to heat the same, and then applying a force to weld or shape the said bars or blanks while heated.

436,571. Trolley for Electrical Railways; David A. Ainslie, of Richmond, Va. Application filed May, 1890. A trolley or contact wheel, consisting of a grooved rim portion made in one piece, a broad hub made of two cup portions, each secured to an opposite side of the centre of said rim portion, and a shaft passing loosely through the centre of said two cups.

436,602. Storage Battery; William B. Hollingshead, of Bronxville, Assignor of one-half to Sidney H. Carney, of New York, N. Y. Application filed Dec. 20, 1889. In a secondary battery the combination, with a red-lead cathode and an iron anode (in charging) of an electrolyte composed of water and a salt which, during charging, will be decomposed into its acid and alkaline constituents, and whereof the alkali remains in solution and acts as an electrolyte during reverse action, while the acid is decomposed and deposits on or combines with the anode, or both, producing a compound insoluble in the electrolyte, acting as the cathode during reverse action.

436,640. Electrical Automatic Fire-Alarm System; William F. Singer, of Carthage, Assignor to the Singer Fire Alarm Company of Buffalo, Limited, Buffalo, New York. Application filed March 11, 1889. In an electric fire-alarm system, the combination, with a main circuit connecting outlying signal stations with a central office, of an auxiliary circuit connecting the outlying stations and the central office by different routes, the auxiliary circuit being normally open at the several stations, a relay at each station and connections for cutting in the auxiliary circuit and cutting out the main circuit upon rupture of the latter, and a switch at the central office for throwing the main or auxiliary circuit into operative relation to the receiving instruments.

436,677. Electrical Head-Light; James Thorne and Ebenezer Banton Burr, of London, England, said Burr Assignor to said Thorne. Application filed June 8, 1888. A lamp, consisting



No. 436,465.—ARC LAMP.

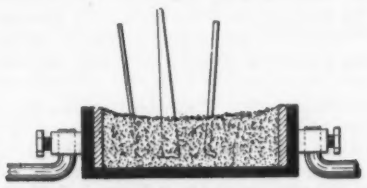
of a closed casing, a lens set in said casing and having a plain interior surface and an approximately parabolic external surface, a reflector having a contour corresponding to the exterior of the lens, the foci of said lens and reflector being in the same axial line, and an electric lamp, a battery and connections all inclosed in the casing.

436,717. Holder for Phone-Receivers; Jehiel T. Moore, of Minneapolis, Minn. Application filed Sept. 16, 1889. The combination with a telephone or other sound transmitting instrument and a receiving-phone, of an adjustable arm pivotally supported at one end to a suitable support and carrying at its other end a receiver-holder, means for securing said arm in any desired position, and a connection between said arm and the telephone-switch.

436,728. Motor-Armature Car Wheel. Edmund Wagemann, of Little Rock, Ark., Assignor of six-sevenths to John D. Adams, Dean Adams, Oscar Davis, John W. Davis, Horace G. Allis, and John B. Jones of same place. Application filed Oct. 17, 1889. In an electric car the combination of car wheels provided with motor armatures lying within the tires of the wheels and attached thereto, field-magnets parallel to the axles of the wheels and having pole pieces at each end and within inductive proximity to the said armatures, and rods attached to the truck of the car and carrying the said field magnets.

436,740. Printing Telegraph; John B. Odell, of Chicago, Ill., Assignor to the Printing Telegraph Company of Illinois, of same place. Application filed May 10, 1886. In a printing-telegraph, the combination of prime motor, a type-wheel, an armature rigidly connected with said type-wheel, and an electro-magnet carried by said prime motor and adapted when energized to attract said armature, thereby transmitting motion to said type-wheel.

436,742. Electric Motor Car; Wm. Robinson, of Boston, Mass., Assignor to the Robinson Radial Car Truck Company, of Portland, Maine. Application filed April 12, 1889. In a motor car or truck, the combination, the driving-axle and wheels, and a motor arranged to drive the same, said motor and axle being



No. 436,519.—HEATING BARS BY ELECTRICITY.

movable together in a horizontal plane relatively to said main frame.

436,743. Electric Motor Car; William Robinson, of Boston, Mass., Assignor to the Robinson Radial Car Truck Company, of Portland, Me. Application filed Feb. 19, 1890. In a motor car or truck, the combination of two driving-axles with their wheels and two motors, one arranged to turn each of said axles with its wheels, said motors with their respective axles being movable relatively to each other in a horizontal plane.

436,747. Municipal Signaling Apparatus; Joseph W. Stover, of Brooklyn, N. Y. Application filed March 21, 1889. In signaling systems for transmitting from sub-stations to a main station multiple signals of different significance and importance, the combination of a battery and a main line leading therefrom and connecting the sub and main stations and normally grounded on one side of the main station, a signal-recording device and a suitable resistance located in the grounded side of the main line at the main station, said recording device responsive to makes and breaks in the same line, a multiple-signaling box located at each sub-station and effecting changes in the main line to transmit signals, said box provided with a normally open ground and means for connecting the open ground with the main line when the box is operated to send an important signal, and an audible alarm located at the main station in the opposite side of the main line from the normally grounded side thereof and responsive only upon the grounding of the sub-station box in transmitting an important signal, whereby certain signals transmitted may be registered by the recorder, but only the more important ones announced by the audible alarm.

Copies of the specifications and drawings complete of any of the patents mentioned in this record—or of any other patents issued since 1886—can be had for 25 cents. Give the date and number of patent desired, and address The W. J. Johnston Co., Ltd., Times Building, N. Y.

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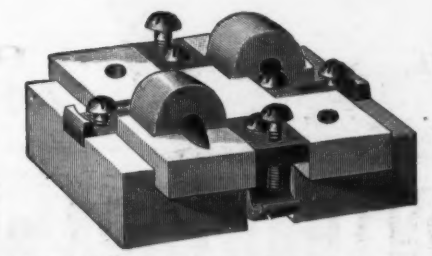

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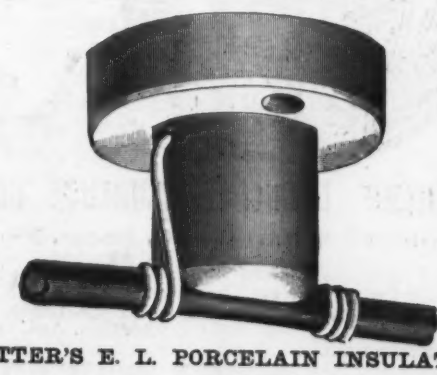

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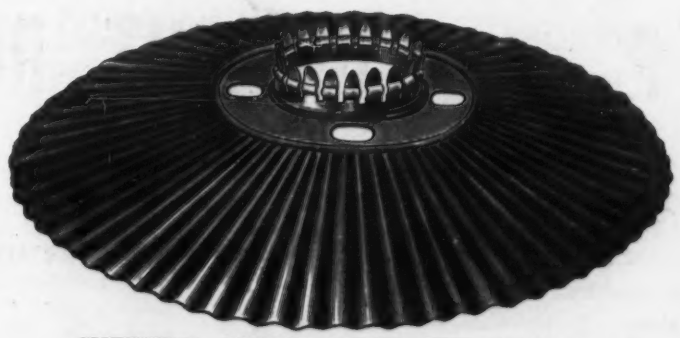

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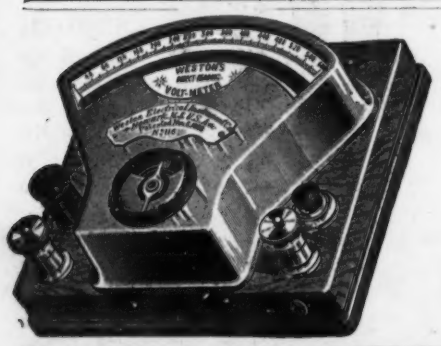

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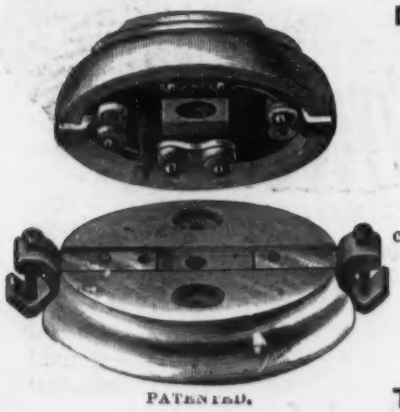

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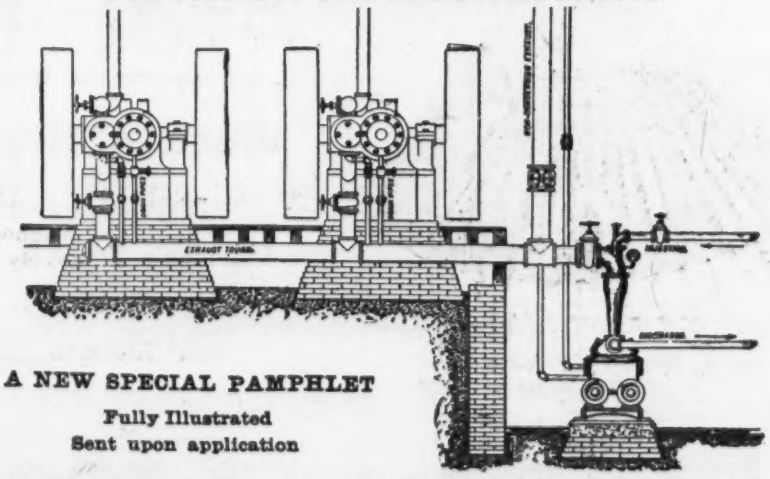

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